
# SPACE RESEARCH IN INDIA UP TO 1996

## A Select Annotated Bibliography

**DISSERTATION**

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*BY*

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*The only protection comes from Allah,*
*the true one*
*He is the best to reward and the best*
*to give success.*

***AL-KAHF***

*.... To my ever loving vapappa.*

## CONTENTS

**ACKNOWLEDGMENT**

I take this opportunity to express my deep sense of gratitude and indebtedness to my learned supervisor, **Mr. Shabahat Hussain**, Chairman, Department of Library and Information science, Aligarh Muslim University, Aligarh, for his valuable guidance, critical discussions and timely advice in multifarious ways, throughout this work.

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**( ASHATH .A.I )**

## PREFACE

The out look of our universe is changing day by day with the advance in the field of science and technology. One of the most important developments has been going on the field of space technology. This with all its high-tech sophistication, is slowly working its way into ordinary society.

The present study concerns with the developments in the Indian space Research and its application in the basic issues of our country like resourse management and communication facilities etc. Although the bibliography is selective in nature an attempt has been made to cover all aspects of the topic. I hope this bibilography would be help full to those who wish to know about the subject

This work includes three parts,

Part 1: Descriptive part

Part II: Annotated bibliography,

Part III: Index and list of periodicals scanned.

## METHODOLOGY FOR DATA GATHERING.

For literature search, secondary sources such as Indian science Abstract, Index India, bibliographies prepared by VSSC documentation section were consulted, these directed to the primary sources like priodicals containing research articles. The title of periodicals

used for compiling the bibliography are listed in the part III of this work.

The following libraries were visited to collect the materials:

1) Vikram Sarabhai Space Centre, Trivandrum.
2) Kerala University,
3) Calicut University.
4) Department of Physics, A.M.U
5) Zakir Hussain College Of Engineering, A.M.U
6) Mdulana Azad Library, A.M.U

**Standard followed:-**

The Indian Standard recommended for bibliographical reference (IS:2381-1969) was followed. The relevent bibliographical details were noted down on 20x 12 cm cards. An attempt has been made to assign subject headings as co extensive as possible. The subject headings were arranged in an alphabetical sequence of various elements. At the end alphabetical Index of author and title were prepared. Index provides reference to various entries by their respective number.

**ARRANGEMENT:-**

The entries in the bibliography are arranged alphbetically under the subject heading.

The entry element of the author is in capitals, followed by the scondery elements in parenthesis using upper and lower case and then the title of the article,

subtitle (if any), then name of the periodical being underlined follwed by the volume, issue number, the year, the month in full or abbreviated form, inclusive notation of the pages of the article. Then each entry is followed by indicative, annotative and descriptive abstract of the article.

Entries are arranged as follows:-

a) Serial number .

b) Name of the author(s)

c) A full Stop.

d) Title of the contribution including sub-title and alternative title if any.

e) A full stop.

f) Title of the periodical being underlined.

g) A full stop.

h) Volume number.

i) Comma (,).

j) Issue number.

k) A semi colon (;).

l) year.

m) A comma (,)

n) Month .

o) Comma (,)

p) Date.

q) Semicolon (;).

r) Inclusive pages of the article.

s) A full stop.

Abstract :- Each entry is followed by an informative abstract .

SPECIMEN ENTRY

3) RAO(UR). Space for sustainable development . Journal of space craft technology. 5, 1; 1995, January; 1-10. Introduces the concept of integrated sustainable development and brings out the role of space technology, through synthesising its two different applications ie, remote sensing and communication these extended to meteorology, T.V broad cast, education, agriculture, industrial growth, resource management, environmental pollution, disaster mitigation, flood and drought management virtually touching every facet of human endeavour.

INDEX :-

Authour and title index have been given seperately. Hope this would be help full for easy consultation.

# *Part one*

# *Descriptive Part*

# INTRODUCTION

## 1. SPACE AGE:HISTORICAL PERSPECTIVE

With the dawn of space age man has began to realize the need to utilize larger portions of space around the planet earth.

The progress is space technology has made it feasible to place sophisticated space systems in the application for the benefit of mankind and society. The purpose of space flight is to provide significant contributions to the physical and mental needs of humanity on a national and global basis. Such contributions are specifically in the areas of (1) Earth resourses of food, forestry,atmosphere, environment, energy, minerals, water and marine life.
(2) Earth and space sciences for research (3) Commercial material processing,public services. Advances in space science and technology during recent years are best charecterised as explosive . The dynamic nature of developments in space probes, rocket vehicles, data handling and communication system make the task of capturing a candid view very difficult .

Hundreds of years were to pass before the motions of the planets about the sun and immense distance be appreciated . Awareness of the Universe evolved slowly until tools of observation were developed .

In the 17th centuary Galileo used the telescope to

study the moon, added geartly to contemporary knowledge Further observations with the telescope confined the pattern of the solar system described by Copernicus,keplerr calculated the elliptical orbits of the planet .

In the end of the 17th centaury Issac Newton formulated the "laws of gravitation " A hundred years later the first free balloon ascents made and the journey upward and away from earth. All these paved the way for todays sophisticated space technology .

On October 4,1957 the Soviet Union lauched the world's first artificial satellite," sputnik-I" and set in motion. A series of programms of space exploration by the United States and Soviet Union were conducted during this time . The first U.S satellite," Explorer-1"was launched on Jan 31, 1958 . Both nations particpated during the next decades in a space race with more than 5000 successful launches of satellites and space probes of all varieties which,include satellites for scintific reserches , communications, meterologicals photographic reconnaissance, and navigation, lunar and planetory probes and manned space flights.

The first active stellite in geo synchronous orbit was launched by the U.S in February 1963 and was called "syncom-1." The first geostationary satellite to be succesfully tested for communication capabilities was

"SYNCOM-III" in 1964 . Excellent television pictures of the opening ceromonies of the Olympic games hild in Japan in October, 1964 were recieved in the United States via "SYNOCOM-III" and several successfull transmission of short duration were made on subsequent days.

## 1.1 SPACE RESEARCH: A GLOBAL VIEW

Some of the most interesting research satellites include those which are designed to assist in porecdiction. Of the weather and to give warnings of approaching fronts, depresions, cyclones and so on . Many televised weather reports, world wide, . Now make use of these satellite pictures we can explain the most likely short and medium form weather patterns . Other types of satellites scan the earth's surface, Pinpointing, Promising sites of meneral deposits early warnings of developing crop diseases.

Astronmical satellites too are examining the Universe in the infra red, X-ray and gamma -ray wave lengths. These satellites produce information unobtainable in any other way . The earth's atmosphere fitters out most or all of such wave lengths emitted by celestial bodies, which means that ground based observers cannot detect them .

The geostationary communication satellites are of special interest because they have orbits which are at such a height that they orbit the earth once every 24 hrs. A satelite moving from west to east with a 24 hrs circular orbital period is said to have a synchronous orbit or is a synchronous satellite. The special case in which the orbital plane of the synchronous satellite is the same as Earth's equatorial plane, the satellite is referred to as geostationary, that is stationary with

respect to earth. Geostationary satellites have important roles in international applications such as communication and meteorology.

As they appear stationary above fixed points on the earth's surface, they are ideal vehicles for effecient long distance communication. We can see such satellites, usually a little after, sunset or just before sunrise. Being so high above the earth's surface they reflect back the sun's light, even though the sun is below the horizon.

The detailed study of the behavior of satellite in orbit can be useful for providing vital infromation. By timing the motion of satellite acsoss the background of fixed stars, information can be obtained about the precise shape of the earth, it also permits more accutate prediction of satellite appearnences.

Artificial satillite vary in brightness, depending on the height at which they are orbiting and on their size. They can best be divided in to three classes.

(i) Bright satellites visible to the unaided eye.

(ii) Those which are dimmer.

(iii) And extremely faint satellites.

All satellits transmit their information back to earth by radio signals, some of which have been picked up by Ametuar astronomers. Generally speaking a powerful short wave recievers and a large aerial system, or antenna are required for satallite data reciveing .

Man invented artificial satellites to help them to

study the earth, sun, Planets and stars and thus to solve the mysteries of nature. So many countries now have their own position in the space. We read latest artificial satellites that have been put into orbit around the earth, time to time from the newpapers . Now there are thousands of them circling our planets. Some have already completed their tasks, while others continue to keep watch up these in space . Most of the satellites are either Soviet or American. Now a days, space crafts appear from other countries like France, China, Japan and India .

There are communication, navigational, and weather and earth resourses satellites which have revolutionalized the world in which we live. As the balloonsts used to speak about thier "birds eye view" of the earth the astronauts get what is termed as "God's eye view ". The remote sensing satellites give us the view of the earth above which means that we get better means to manage earth's land resources, like agricultural, crops, forestry products, water resources , minerals ,wild life as well as recrational and environmental resourses . Better monitoring now enables us to manage all those resourses wisely. The design development and operation of all these space systems depend on upto date knowledge of the impact of physical processes in space on these systems . Considerable research is going on to understand the effects of earth's magnetic environment both on

ground based and space based tecnologies.

These satellites, whether it is communication or remote sensing satellites, transmit data back to man millions of kilometers, of empty space as radio wave as links . These frequently stored data for later transmition to earth . The basic commodity of communication is information. An extremly important, but often unrecongnised link in the comunication chain stretching from the space craft sensor to the human being , who finally evaluate the data in the final piece in the chain with the data processsing and display equipment . The data automation is done by the manipulation and partial reduction of data by digital computers.

The search for scientific knoledge, explaration of the unknown, and establishment of man's capability in space have been and remain primary goals of national space programmes . However, Earth oriented satellites also known as " application satellites"are of direct economic benifit are bring placed in operation.

There are three general classification of such satellites(Application satellites). These are communication satellite, earth survey and navigation satellites

## 1.11 APPLICATION SATELLITES

### 1.3 Communication Satellites

Not so long ago, television was a rarity, but now a days there is one in vitually every home. We have grown used to it , and do not think much about how an image

appears on the screan .

The cameras are set up in the theatre or stadium and their lenses focus on the stage or the green field . Everything that can be seen through the lens the outdoor playing their parts, the set, the audience or the sports man is now turned in to invisible signals, ie, radio waves in various directions and they are recieved by aerials connected to telivisions in peoples houses. Inside the T.V. sets these invisible signals are turned back into an image. That is the picture which we seen on our screen.

In order to transmit a T.V pogramme over a large distance a T.V aerial has to be set up high above the earth. For that purpose a new idea has been emerged in to fit an aerial on the satellite which is revolving around the earth once in a day. It recives the signals transmitted by the T.V station strengthens them and sends back to earth . These satillites enable people not only to watch T.V programmes but also make long distance telephone calls or send and recive telegrammes . These satellites provide means of communication between pople and are called communication satellites.

Quite recently satellite have been brought into help sailers and aircraft passengers who have suffered an accident. The first such satellite was the Sovite "Kosmos-1383" .

A canadian light aircraft had to make a forced landing in a forested mountainous area in British Columbia . The piolet sent out a SOS caught the signal. It immediatly informed the concerned station and within hours a rescue plane discoverd the unfortunates.

An international organisation called international satellite rescue services for ships and aircraft which had been set up firstly by Soviet Union, U.S.A , Canada and France . The aircraft and ships of these countries were equpped with special beacons which send out SOS in case of accident. The satellite piks up the signal from the altitude of its orbit and rebroad casts the signal. As soon as people on earth recieves the signal they rush to the assistance of those in distress .

Examples of communication satellites are Mritime satellite system (Marisats), Intel Sat , Soviet Maloniya emsats, Ats ETS.

**1.112 <u>Weather Satellites:-</u>**

This broad catagory of satillites has progressed from relatively simple photography to include many forms of observation of the earth . Meteorlogical or weather, satellites operate globally . From a polar orbit photogrphs of the earth's surface are taken by television . Scanning and transmitted to earth reciever stations . In addition the Meteorological satellites in geostationary orbit have the advantage of continuous watch over large region of the earth . global observation

of weather by satellites has become important to all nations. Tracking of hurricane formation and movement has permitted advance warning, saved nunberless lives and minimized property damage.

The first weather satellite was TRIOS - Telerosion and Informed Observation satellite . The world's first Synchronous Meterological Satellite SMIT was launched by the U.S.

### 1.113 Earth Resources Satellite or Remote Sensing Satellite

The United States launched the first earth resources Technology satellite (ERTS) in 1972. In polar orbit at an altitude of about 910 kilo mitre, it transmitted to the earth multispectral images that proded data to hundreds of scientific investigation in many disciplins agriculture, froestry , minral and land resources , land use, and water and marine resources.

ERTS was renamed as LAND SAT and in Januwary 1975 Land Sat 2 was shifted succesfully . Some of the most valuable uses of earth surveys made by orbiting space craft have been estimating crop acreage, monitoring urban development, planning future land use,locating air water pollution and locating geological imformation.

## 2. SPACE RESEARCH :-INDIAN SCENARIO

All that stands changed today as the space research reaching the common man in the remotest corner of India . The Indian space research with all its high-tech sophistication is slowly working its way into ordinary society .

The central objective behind space programme is to put to work space science and technology in aid of the country's developmental efforts . The areas chosen for applications, are those where satellite based systems have an inherent edge over conventional earth bound systems .

Considerable progress has been made in creating the basic infrastructure, in developing various facilities and in aquiring a whole range of capablities in the area of space technology . Much of this has been accomplished indigeneously but asssistance from friendly countries has been quite valuable .

The remakeble advances in space science and technology during the last two decades have unambigously demonstrated that it is possible to harness this technology for developmental purposes . Having been understood the benefit of this technology in communication, remote sensing, geodesy, navigation, oceanography, minerology and geography, India has established a remarkable place among the countries, which are having greater advances in space research.

The most remarkable feature of satellite technology is its ability to obtain an instantaneous global view of large continents and land masses. With near earth, polar orbiting satellites carrying infrared and visual camera system, it is possible to obtain high resolution global pictures for surveying natural wealth and resources in agriculture, forestry, hydrology to facilitate the opti mal utilisatin of these resources. Geostationary satellites provide a unique means of instataneous communication and T.V transmission throughout the country. For a developing contry with a large rural population, this aspect of space technology, has for the first time provided the capability of utilising the most powerful audio-visual media for educational purposes, for improving agricultural practices and for providing information on health hygiene and family planning . Also from the large global coverage made possible through geostationary satellites reliable advance in weather prediction is now well within the practical reach of nations. The possibility of economically producing exotic materials and medicines in space and even harnessing large scale solar power using this technology seems to be a matter of time.

## 2.1 Historical Perspective:-

Reasarch in the field of Physics of the upper atmosphere and astrophysics began in the first half of the twentieth centuary , when Indian science was an

activity of individuals largely from centres of higher learning such as Universities . After independence, scientific activity took an entirely differnet turn; the idea that science and technologh could be harnessed for national development gained widespread spport .

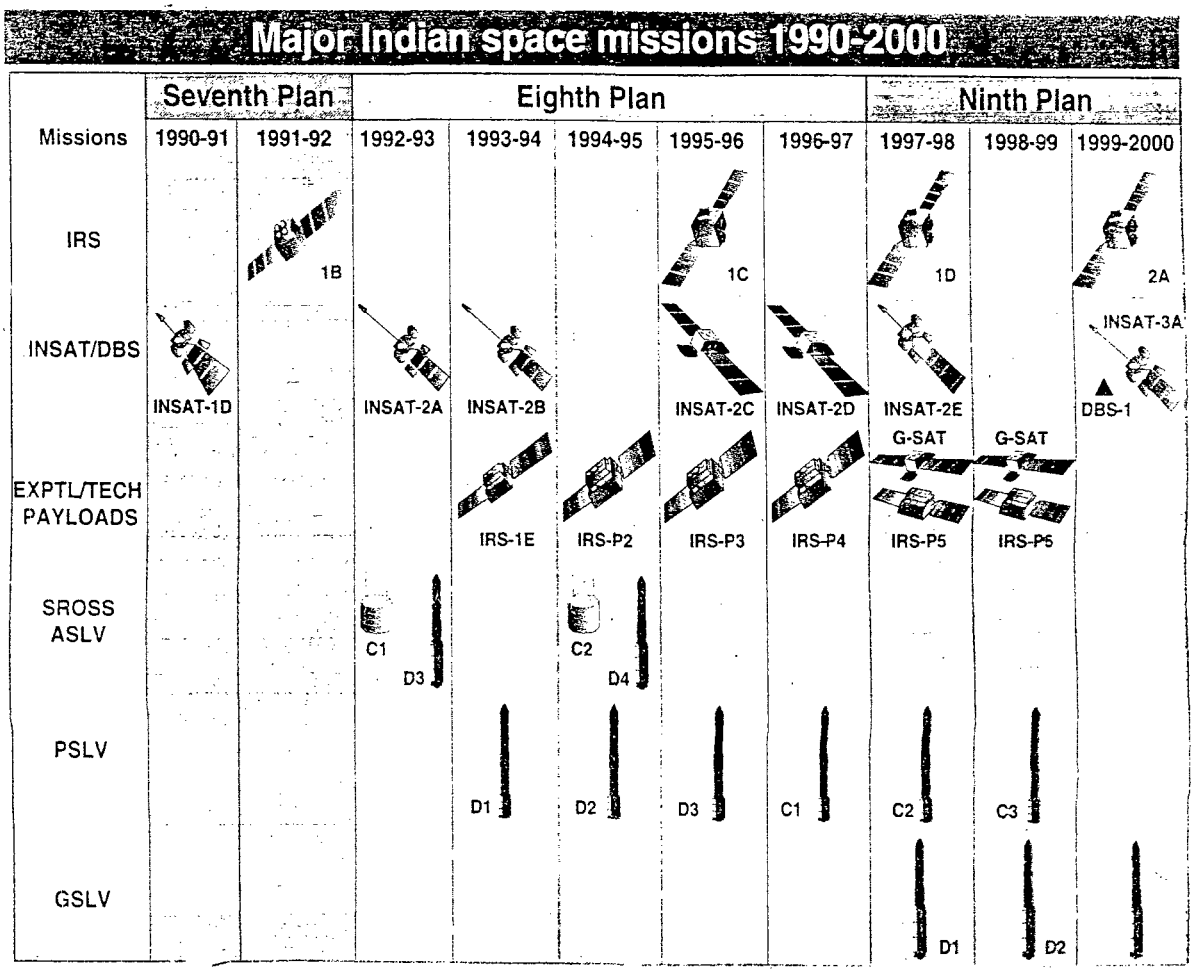
By the late fifties a strong base had grown within the country in respect of studies of the near earth environment and other space science related areas. Most of this work was based on ground based techniques for inospheric and magnetospheric studies thougha significant base for ballon born space science experimentation was already natural for Indian space scientists at that point of time to want ot entend thier activities in studies of the uppen atmosphere based on the knowledge and the experties gained earlier.

This desire is what prompted India's entry into the field of rocketry.

Given this back ground, the Department of Atomic Energy (DOE) which in 1961, had been entrusted by the govt of India with the subject of the peacful uses of outer space set up the Indian National Commities for space research (INCOSPAR). IN 1962 to advise and help recognise Indian space programme , heaed by Dr. Vikram Srabhai . When we talk about India's space programme, it is essential to mention his name, as he gave formal shape to India's space research programme. Indeed it is with his vision India is staring towards today .Sarabhai, was perhaps the first to stress the importance of using

advanced and sophesticated technology. all these effects of Sarabhai, he is referenced as the father of Inian space programme . In a lecture he said,

"There are some who questions the relevence of space activities in a developing nation . To us thre is not ambiguity of purpose . We do not have the fantasy of competing with the economically advanced nations, the exploration of the moon on the planets on manned space flights . But we are concived that if we are to play a meaningful role nationally and the community of nations we must be second to none in application of advanced technology."



## 2.2 Satellite Communication:-

For a large country like India , with a population which is expected to cross one billion mark as it enters the twenty first centuary communication will play a significant role in its overall development. Information dissemenation plays a very important role in improving human understanding and international relations.It plays and equally important role in human uplift and industrial progress within a country. In the modern world which according to Marshall Mc Luhan , is turning to a "Global village" due to communication explosion , One cannot isolated and has to keep pace with what is happening around the world . The emerging consept today is to have communication with anybody anywhere everytime . To emphasis from now onwards should be not to just follow the western world , but aims at coming to stage by 2010 whereby India should contribute to the shaping of the future . To some extent , this has been done earlier also in planning the largest communication experiment in the world that is "SITE" and the bold decision of having the "3 in 1" concept for INSAT satillites in spite of the skepticism of many leaders in this field around the world.

With very succeseful implementation of the satellite communication plans in providing national coverage in all fields of telecommunication, namely T.V and Radio via the

INSAT system, the country is well poised to forge ahead to achieve total self reliance in this area . The plans for the corrent decade are bold and emerging as a leading nation in the world in this arena by 2010 is quite realistic.

The area to be covered in this field is very wide . Telecommunications both satellite based and terrestrial are complementary to each other .Hence integrated planning in this area has to be done with well thought out apportioning of satellite basedand terresterial science . The low earth orbit (LEO) satellite based services are being thought of . One has to be actively involved in order to come out a distinct role in this new area when it becomes operational . The expansion of T.V and Radio to meet the sociological development, entertainment and educational requirements will be very substantial and may even having dedicated satellites to meet these requirments . The role of satellites and guidence, search and rescue, disaster warning and distress dcommunications and many such related fields meeds to be addressed while planning for the first decade of the 21st centuary . The requirement of defence services and other security agenceis for satillite based communication features needs to be looked into and necessary plans to meet the same have to be established .

**Space Research in India;at a glance**

The Department of Atomic Energy (DAE) which in 1961

had been entrusted by the Government of India with the subject of the peaceful uses of outer space set up the Indian National Commitee for space Research (INCOSPAR). In 1962 to advise and help recognise India's space programme TERLS (Thumba Equitorial Rocket Launching Station) was established .

India's obssesion with space began in 1963, barely six years after world's first satellite went its orbit.

1965:- First sounding rocket launched from TERLS .

1965:- SSTC establish in Thumba

1967: satellite communication earth centre at Allahabad

1969:- Rohini- first Indian rocket development successfully launched .

:- ISRO set up for the peaceful exploration of space.

1972:- the space comission and the departmetn of space (DOS) set up ISRO to work under the DOS .

1975- Aryabhatta, the first Indian satellite was succesfully launched by a soviet rocket from a soviet cosmodrome on April 19, into a near circular orbit at hight of 600 km.

1979:- Bhaskara - I the second Indian satellite launched form the Soviet Union on June-7 .

1980:- The Indigenous satillite launch vehicle SLV-3 puts Rohini "satellite" into a near earth ecliptical orbit from "SHAR" on july 18 .

1981:- SLV-3 carrying a 35 kg "Rohini" satellite from

SHAR on May 31; APPLE launched .

1982:- INSAT - 1A, the first multipurpose Indian stational satellite ,built by ford Aerospace launched.

1983:- A Geostationary satellite INSAT-1B launched

1987:- ASLV took off.

1988:- INSAT- 1C, IRS- 1A.

1990:- INSAT-ID ,At the end of 1990, INSAT-U series of satellite have been become operational

1991:- IRS-1B .

1992;- INSAT- 2A launched from French Guyana on July 10, ASLV-D3.

1993:- INSAT-2B launched on 23 July 1993 by the Ariane launch vehicle.

: PSLV- D1.

1994:- IRS- P2.

: PSLV-D2.

: ASLV-D4 .

1995:- INSAT- 2C.

IRS-1C.

IRS-P3.

PSLV-D3.

This concept underlies the structure and organisation of the Inian space programme .Indian satellite programme involves two types of satellite communication and Remote sensing.

Forseeing the vital role that satellite communications should play and the need for trained manpower in this field, an experimental satelite communication earth station"ESCES" was set up in 1967 at Ahmedabad, with the support from the United Nations Development programme (UNDP) and the international Telecommunications union (ITD) .

The Indian space research organisation (ISRO) was set up in 1969 by the DAE to deal with matters relating to "space ". Actually ISRO is the metomorphosid name of INCOSPAR with Sarabhai as the first chairman . ISRO the research and development wing of the department of space (Dos) executes the national space programme . In 1972, the Govt. set up the department of space under a space commision took charge of ISRO and is now responsible for the country's space programme .

The space science studies involves the area of cosmic rays, astrophysics,space astronomy,meteorities etc. Here we are concered with the earth oriented space research areas such as:remote sensing , meteorology communication etc.

Satellite and launch vehicles are no doubt essential ingradients of space technology, but a satellite in orbit is of little value unless it form part of a complete application systems designed to meet specific needs . This system concept underlies the structure and organisation of the Indian space programme.

## 2.3 SATELLITE TECHNOLOGY:-

India now prosses technologieal and other capabilities to plan,design,fabricate and test satellites for science experiments as well as for practical application such as earth observation (Bhaskara, 1979.)and communications (APPLE 1981). Aryabatta carried three space science experiments in X-ray astronomy , solar physics and aeronomy even though its main aim was to demonstrate indigenous capability for designing and fabricating satellites .It was launched by Soviet rocket

### 2.31 APPLE:-

Weighing about 600 kg was a three axis stabished geo-synchronous experimental satellite for communication. It was launched by the European space agencey's Ariane launcher on June 19,1981 form Kourou French Guyana .

**APPLE and its Utilisation (Ariane passanger payload experiment)**

APPLE a three axis stabilished geo-synearonous communication satillites was fabricated indigeneously . It was launched by the European space Agency's Ariane launcher on June 19,1981 . An indigenously designed and built apogee boost motor on board APPLE boosted it from a transfer orbit to the geosynchronous orbit. This experimental satellite carried a C-band transponder and, during its two-year life time several communications experiment were conducted . These cover areas of computer

communications, time division mulutiple areas spread spectrum techniques as well as use of small terminals. Some social and educational experiments with APPLE have also been conducted. Some of them are .

1- Computer Networking between a number of computers located at different places .

2- Television with multiple Audio demonstration using both Ahmadabad and Delhi studio.

3- Use of small communicatin Terminal for various applications such as emergency communication during post disaster relief operations, business communication for bank, paper mill and facsimile for press as well as newspaper.

4- Tele syposium on satellite communication in the form of video lectures originating from Ahmadabad, transmetted to graduate post graduate students at different locations including a returne audio link for question answer session.

5- Tele- press confernce involving 3 locations.

**2.32 Bhaskara**

The Government of India realising the importance of operationalising remote sensing, created the Natinal Remote sensing Agency at Hyderabad in 1975. India's first experimental earth operation satellite Bhaskara sent data since data since it was launched in to a low earth orbit in June 1979 until it was shut down the microwave radiometer ,

SAMIR onboard Bhaskara has provided data that was useful in derving meteorological parameters such as atmospheric water content, horizontal moisture gradeants, ocean surface winds and precipitants rates over oceans .

## 2.33 Bhaskara - II Satellite:-

Launched in November 1981, The T.V and SAMIR payloads onboard of the space craft was functioning normally. SAMIR data are being used for studies of sea-surface phenomena and atmospheric water vapour and liquid water content estimates . The T.V, payload was operated in manual mode upto Aril 1988 . Data collected from the Bhaskara -II,T.V SAMIR and DCP payloads have been used for various applications.

## 2.34 Rohini (RSD-2) Satellite:-

RS-D-2 satellite was launchede on April 7,1983 by the SLV-3-D-2 launch vehicle form sriharikota . The sacecraft designed for a ninimum mission life of 100 day's has completed over 250 days inorbit and has performed satisfactorially.

## 2.35 INSAT Programme:- (Indian National Satellite system)

With the successful launch and operationalisation of INSAT -2C,the INSAT system has become one of the largest domestic satellite systems in the world, providing a multiplicity of services that the nation has come to depend on almost routinely . The followings are the major INSAT

system development.



1- Organisational structure.

2- INSAT system planning .

3- Orbit and frequency Co-ordination for INSAT.

4- INSAT system utilisation and services .

5- Ground segment Development .

6- Future plans.

### 2.351 Historic Background:-

The idea of a domestic geostationary satellite system for India for broadcasting T.V programmes for development was first mooted by late Prof. Vikram sarabhai is the late sixties . Following this several studies to examine the potential of nation wide T.V for development and the feasibility of establishing a domestic satellite system were carried out. These joint studies in all of which the ISRO took the lead role included participation on of other Goat of India agencies , UNESCO,NASA ,and the satellite industry of the U.S.A . In March 1970, Prof. Sarabhai presented an invited paper at the National conference on electornics held in Bombay, spelling out the basic primeses of use of satellite for developmental communications and the broad systems details of the Indian National satellite system INSAT. The paper set out the philosophy of procuring the first satellite from abroad and building the follow- on satellites in India .

These studies inspite of the wide participation in depth analysis and clear understanding did not give

straight away results in a consensus on the cost effectiveness of the satellite medium for domestic telecommunication and T.V services . The proponents for terrestrial wide band argued that for a country like India with high density of population and diverse culture and languages , terrtrial systems offer much more flexibility and other advantages . Finally in a National seminar conducted in 1972, it was recognised that satellite and terrestrial media should not be considered as conpeting systems but as complementary systems . It was agreed that a hybrid system combining the best features of both terrestorial and satellite media would result in the quick implementation of a flexible costeffective and reliable programme .

Indian National Satellite system .(INSAT)

Established in 1983 with the commissioning of INSAT-B1 is a first venture of the Department of space (DOS) Department of telecommunication India, Meterological Department,All India Radio and Doordarshan . DOS is responsible for the establishment and operation of INSAT space segment.

The succesfull launch and commissioning of the third ISRO built satellite in the second geration INSAT-2 series, INSAT-2C on December 7, 1995 has further enhanced the INSAT system capablities . INSAT -2 launched in July 1992 ,INSAT -2B launched in July 1993 and INSAT- 1D the last of the INSAT-1 series launched in 1990 ,continue to function satisfactorily providing uninterrepted services for tele communication,T.V broadcasting, disastor warning

and distress alert services .

The communication payloads on board of the first two satellites in the INSAT -2 series,INSAT-2A and INSAT-2B which are identcal comprise 12-c band transponder,six extended C-band transponders and two high power S-band transponders .The meteorological payload includes a very high resolution Radiometer (VHRR) with 2 km resolution visible band and 8 km resolution in infrared bands, and a tranponder for meteorology data relay . These satellites also incorporate a transponder for reciving distance alert signals for search and rescue operations.

INSAT -2C was launched by the European launch vehicle Ariane, from Korrou , Franch Guyana . The satellite was formally commissioned on February 10,1996 . INSAT-2C in incorporates advanced features such as ku-band transponders for business communication entended coverage C-band transponders catering to the population from south east Asia to the Middle east and transponders for mobile satellite services . It doesnot have the meteorological payload. The successful collection of INSAT-2C with INSAT -2B in the geostationary orbit is and importent step towards efficient use of allocated orbital slots for Indian satellites.

Two more satellites in the INSAT -2 series namely INSAT- 2D AND 2E are now under development, INSAT -2D, identical to INSAT-2C is scheduled for launch during 1996-1997. INSAT-2E Scheduled for launch during 1997-98 is

planned to incorporate an improved meterological payload besides the communication payloads as in INSAT-2C and 2D .

. The INSAT series includes,

INSAT-1 SERIES

INSAT-1A

INSAT-1B

INSAT-1C

INSAT-1D

INSAT-2 SERIES

INSAT-2A

INSAT-2B

INSAT-2C

INSAT-2D

INSAT-2E

INSAT-3 SERIES IS UNDER CONSIDERATION.

2.352 **INSAT-1 Spacecraft:-**

With the successful launching on 30th Aug 1983 and subsequent orbit raising and deployment manoeuvers of INSAT -1B spacecraft .The Department of space has the reponsibility for the telecommunications ground segment, IMD for the meteorological ground segment and applications and AIR and Doordarshan for radio and T.V utilisation .

INSAT -1 has been envisaged as a twin satellite system - one satellite being the primary satellite and the other acting as an active on-orbit space with certain major path telecommunication utilisation . The INSAT -1B satellite is functioning as the primary satellite . INSAT-1C has the

active on-orbit space

Each INSAT-1 spacecraft contains twelve 36 MHz wide 6/4 GHz transponders for telecommunications two 36 MHz wide 6/2.5 GHz high power transponders for T.V broad casting and radio and T.V programme distribution, a very high resolition radiometer for meterological earth obnservation and data relay tansponders . The satellite is three axis stabilised with a precision attitude controle system providing the higher order of stability required for meteorology imaging.

**2.3521 INSAT- 1A:-**

Launched in April 11, 1992 by Delta rocket which was built specifically for India by Ford Aerospace communication co-operation of the U.S. This along with the INSAT-1B launched in 1983 along with 35 earthstation form the INSAT to provide telephone and T.V services and keep round the clock watch on weather . The dalta rocket seperated 19 minutes after launch thrusting INSAT -1A into a highly elliptisl orbit ranging from 166 km to over 35, 985 km above the earth . The satellite makes India the eighth country to have its own domestic satellite. The INSAT -1A route telephone calls,monitor weather and broad cast radio and T.V programmes in contrast to existing satellite that are either used for telecom or weather monitoring . Its cost is 17 crore. It was located at west of Delhi. It has 12 transponders that can handle 8000 telephone calls or other data transmission .It is five story tall (19.4m), box typed satellite that has a solar array , the

primary sourse of power generation.

**2.3522 INSAT -1B:-**

INSAT-1B boosts India's telecommunication,Telivision and radio broadcasting and meterological systems in the country. The total weight of the satellite is 1193.16 kg . INSAT -1B is the 9th satellite to be shot into space. When this goes into separation, The Indian post and telegraphs department will disperse with services of INTELSAT satellite leased by it due to the failure of INSAT -1A in september 1982. To link up the main remote areas INSAT-1A is a low earth orbit with about $27.5^0$ inclination ,from its geostationary position. INSAT -1B will provide teliphone,telivision and weather monitoring services for India. The cost of the satellite is much less than that of its predecessor INSAT-1A.

The deployment of c-band antenna is meant for telecomunication and it has 12 transponders .The large silicon cell solar array on the south side of the satellite tracks the sun for the generation of required electrical power of about 900 watts for the satellite. The value of the INSAT-1B to the contry and cost effectiveness will be rated not so much on its sophistication or capability as on the actual performance of the intented mission . The development and creative utilisation of the related software system is for more important and complex . The telecommunication and metrological components confer large national benefits affecting the lives of ardinary people

through improved telecommunication and more reliable by range weather forcasts. Distance learning both through radio and television and informal and continuing education combined with tape and vedio technology has enormous possibilities.

**2.3523 INSAT -1C:-**

The INSAT -1C which was launched from Cape Canveral was a failure . It delayed the expansion plans for both the television and telephone network in India.

**2.3524 INSAT - 1D**

Launched in June 1990 in the last of the first generation INSAT satellite procured from the United States, which is presently in service.INSAT-1D like the othe INSAT -1 series of satellites carries twelve C- band telecommunication tranponders,two high power S-band T.V.broad transponders,a very high resolution Radio meter (VHRR) for meteorological earth imaging and a data relay transponder for relay for meterological hydrological and oceanographic data from unattended land and ocean based platforms INSAT-1D is positioned at 83 degree east longitude and it supports fixed satellite services (FSS). Broad cast satellite services (BSS) and (VHRR) services .

**2.353 INSAT - 2 System**

INSAT-1 space segment and the associated spacecraft configeration were defined on the requirments of satellite services during the 1990's envisaged by the user agencies namely DOT ,IMD, AIR and Doordershan. INSAT-2 space segment

will have five multipurposess satellite two of them co-located at the primary orbital position and two at the major path orbital positions. The two co-located satellite will be maintained in the orbit to as to appear as a large capacity space craft.

**2.3531 INSAT 2A and INSAT-2B**

These have the following capabilities .

1. Twelve National coverage telecommunications (Fixed satellite communications FSS). Transponders of 36 MHz band width.

2. Six extended C- band tranponders operating in the 4.5-4.58 GHz frequency band .

3. Two high power national coverage T.V. broad cast frequency bands, each capable of handling one direct broad cast T.V. chennels and seven low level carriers for services like radio programme distribution,disaster warning etc. These transponders also support disemmination of disaster warning and standered time and frequency signals.

4. A very high radiometer (VHRR) for meteorological earth imaging is visible and infared bands with resolution of 2km and 8km respectively, having half hourly full earth coverage and sector scan capability .

5. A data relay transponder having global coverage with a 402.75 MHz earth to satellite link for relay of meteorological, hydrological and oceanographic data from unattended land and ocean based outmetic data collection - cum transmission platforms.

6. A 406 MHz /C-band search and resume distress alert

transponder.

INSAT -2A was launched by the Ariane launch vehicle of the Ariane space from Kourou, French Guyana on July 10, 1992 and commissioned on Augst 6, 1992. The satellite is positioned at 74 degree east longitude in the geostatinary orbit. Presently the normal C-band transponders of INSAT -2A are being used by the DoT and closed user groups. The allocation of entended C-band transponders to various uses has also been done . One enteded C-band tranponder has been exclusively allocated for training and development communication services.

INSAT-2B was launched on 23 July 1993, at by the Ariane launch vehicle . The space craft was declared operational on August 10, 1993. and it is positioned at 93.5 degree east longitude .

**2.3532 INSAT -2C Mission:-**

INSAT -2C was launched by Ariane launch vehicle on December 7, 1995 from French Guyana. After the launch and placement in Geostationary transfer orbit (GTO) by Ariane launch vehicle, the satellite was acquired successfully by the INSAT Master control facility at Hasan at Karnataka . After this major events like apogee moter firing deployment of solar arrays and antenna were carried out as per schedule .

INSAT-2C comprises fixed satellite services (FSS) Broad cast satellite services (BSS) and Mobile satellite services (MSS) transponders . It does not carry the

meteorological payloads .

Some channels of the C-band fixed satellite service transponders are used for providing expanded area transmit coverage over south east , central and west Asia , while the remaining channels have Indian National coverage.

Ku -band fixed satellite service tranponders include three Ku -band essential for tracking of large size ground terminals .

Broadcast satellite service transponder has one CXS band transponder used for broadcasting telivision and radio programmes over the Indian land mass including offshore islands .

Mobile satellite service transponder has two communication links.

**2.3533 INSAT -2D:-**

INSAT-2D to be launched during 1996-97 on broad by an Ariane rocket from French Guyana, This will have the following complement of payloads and it will work with a polarisation orthogonal to that of INSAT-2C.

1. Ten normal C-band chennels .
2. Two normal C-9 and C-10.
3. Six extended C-band .
4. MASS transponder.
5. Ku- band transponder.

**2.3534 INSAT -2E:-**

INSAT-2E is slated for launch during 1997-98 . It will

have meteorological payloads and its configuration is similar to INSAT -2A and 2B with single sided solar array. INSAT-2E will carry the following complement of payloads .

1. 17 C-band and lower extended C-band, 36 DBW transponders with zonal and global coverage .

2. A very high rosolution radio meter (VHRR)similar to that on board INSAT-2A/2B but in addition has a water vapour channel.

3. A charge coupled Divise.

Under an agreement with the Intenational Telecommunications satellite Organisation (INTELSAT) DOS with base eleven 36 MHz equivalent units of C-band cpacity on INSAT-2E.

**2.354 INSAT-3:-**

Definition of third genaration INSAT spacecraft INSAT-3 has been initiated. Evaluation of the requirments of various uses in terms of space segment capacity has continued during the year.

**2.355 INSAT MASTER FACILITY (MCF)**

The INSAT Master control facility at Hassan in Karnataka is a multimission control center providing TTC services for INSAT series of space craft . It is also responsible for initial orbit rising of space craft and payload testing.

MCF is an integration facility consisting of five satellite control earth stations.

the spacecraft control centre (SCC) which is the nerve

centre for satellite control operations at MCF and hub of the network interfacing the five earth stations, provides a high degree of flexibility in operations . The communication network provides capability to interact with the user agencies such as Doordarshan and India Meteorological Department, data processing system as well as network oprations control centre on a real time basis .

A back up TTC station has been established at the ISRO telemetry , tracking and command network at Bangalore.

## 2.356 INSAT UTILISATION

### 2.3561 TELECOMMUNICATIONS:-

At present there is a total of 210 telecommunication terminals of various sizes and capabilities ,are operating in the INSAT telecommunications network prociding 4,410 two way speech cercuits or equivalent over 162 routes. These include 126 fixed and captive 20 transportable, 14vvip/ special terminals, 20 fly away terminals and 30 multi - channels per carriar very small Aperture terminals . Over 400 additional earth stations, including 50 satellite based rural Telegraphy network pilot project in the north eastern region are under various stages of implimentation in the DOT network . In the National information centre network (NICNET) there are over 700 micro terminals . Eight closed user group 64 kbps data networks are currently operating through INSAT extended C- band transponders . Under the remote area business message network (RABMN),the master earth station at Secanderabad has been installed and

commissioned .Under low cost terminal (LCT) category 18 type C terminals have been commissioned and for north easten region 16 out of the planned 19 teminals commissioned. Four LCTS in Andaman and Nicobar islands and four LCTS in Lakshadweep island have been commissioned .

Additional networks facilities planned by DoT under INSAT programme during the 8th five year plan including Remote area commmunication through 300 stations using MCPC-VSAT in hilly areas of J&K , MP , UP north east stations etc, digitisation of satellite facility of existing stations and new digital satellite earth stations, high density IDR carries high speed VSAT network provision of long distance subscriber Telephone cnnections to remotely located subsribes using extended C- band and use of fly-away terminal for crisis managements.

Captive satellite based network for NTPC,gas Authority of India (GAIL) , Nuclear Power corporation, Indian Telephone Industry,ONGC ,NFL and coal India limited are operational . The National stock exchange (NSE) VSAT Network in extended C-band become operational in 1994 . A number of captive government networks are also working with INSAT. More organisation are in the process of implementing thier own captive networks using INSAT capacity . DOT has licensed a few private operaters to provide value added services to the public using the extended C-band .

**2.3562 TELEVISION BROADCASTING:-**

INSAT has been a major cataylyst for the rapid

expansion of television coverage in India . Satellite television now cross over 65% of the Indian land mass and over 80% of the Inian population. Five S-band transponders, six C-band transponders and six extended C-band tracsponders on board INSAT -2A,2B and INSAT-1D are providing the following satellite television srevices .

1. National networking sevice (DD-1) and one metro service DD-2 in 2.5 GHz band on transponder of INSAT -1D and INSAT-2B.

2. ETV/UP, Assamese /Nort -East and Karnataka region sevice in 2.5GHz band on CxS-1 transponder of INSAT-1D, CxS-2 of INSAT -2A and CxS-2 of INSAT -2B respectively .

3. Regional services in the extended C-band transponders of INSAT-1D and INSAT -2B .

Doordaarshan's national serevice is being supported on CxS transponder of INSAT-1D. Doordarshan programmes are sent to DoT earth station at Secenderabad and Buland Shahar district of Utter Pradash using terrtorial microwave link from where they are uplinked to the satellite and recived by various Doordarshan centres and relayed by the transmitters . Doordarshan has an extensive uplinking capability at Pitam Pura in Delhi for uplinking varius other channels.

Under the INSAT scheme , 2000 S-band direct Reception sets have been deployed in the states of Andhraparadesh , Orissa , Bihar, U.P , Maharashtra and Gujrat.

2000-VHF community T.V sets have been deployed in selected villags of U.P, Maharashtra , Bihar and Gujrat .

Educational T.V (ETV) Service utilising INSAT was introduced for primary school children is selected three destrict clasters in AndhraPradesh , Orissa Maharashtra Gujrat Bihar and U.P . At prsent educational programmes put out from Delhi through INSAT-1D and relayed through all T.V relay tranmitters are available durig 0930-1200 hr on a time sharing mode.Programmes for the training of school teachers , progrmme based on school curriculum are prepared by Doordarshans kendra's of Delhi Mumbai Madras and Srinager. U.G.C programme meant for higher educations is telecasted in Doordarshan's national network during 1300- 1400 hr IGNOU broadcasts educational programme at 6.00 -7.00 am .

**2.3563 SATELLITE NEWS GATHERING:-**

satellite news gathering has been used several times via the INSAT transponders to enable real time news coverage from the field.

**2.3564 RADIO NETWORKING:-**

Radio networking (RN) through INSAT has beenm designed to provide a reliable high fidelity 10/15 KHz programme. channels for national as well as regional networking of radio programmes . As of octorber 1995 ,182 All India Radio stations have been equipped with S-band recieve terminals . The Radio networking of INSAT system primarily uses CxS band transponder in SCPC mode .Prensently AIR is Utilising INSAT -1D for distribution of radio programme troughout the country . Interective exchange of programmes also takes

place between any two or more uplink stations.

With the availability of INSAT-2 additional 22Rn chennels in CxS of INSAT -2A had been operationalised.

Seven Radio networking (RN) carriers are operational with INSAT -1D in CxS band.

Four transportable uplink terminals have also been acquired by AIR which are capable of operating with INSAT 1/2 series of satellites and are being utilised for coverage of events taking place at remote locations and for relay of programmes directly from the spot.

**2.3565 SATELLITE AIDED SEARCH AND RESCUE-**

India is a member of the International COSPAS-SARSAT programme which provides distress alert and position location service through low earth orbiting satellites . Appropriate ground segments has been operational since 1989 and the special 406 MHz beacons have also been developed in the country . The beacon's are associated in the first two of INSAT-2 space craft . Besides U.S India is the first country in the world to incorporate the geostationary satellite component for search and rescue.

**2.3566 PTI'S SATELLITE NEWS and FASCIMILE DISSEMINATION PROJECT:-**

The press trust of India is the major purveyor of news and information in the contry . PTI is implimenting a system to provide its new's and information services higher speed and in increased volume and variety directly to a wider range of media and other users across the country by utilising the

broadcast facilities of INSAT-1D satellite . The roject will utilise a Radio Networking type channels on one of the broadcast (CxS) transponders of the satellite.

**2.3567 MOBILE SATELLITE SERVICES:-**

With the launch of INSAT-2C ,an S-band Mobile satellite service (MSS) is being introduced in the country shortly. The following three classes of services have been identified for MSS.

1. Low bit rate encoded voice data and fax services using demand assigned SCPC channels, with mobile and portable terminals.
2. Low bit rate store and forwared messaging service using shared channels with mobile and portable terminals .
3. Low bit rate reporting service using shared channels, with portable and land held terminals . The INSAT - MSS is targted at land mobile and maritime user.

**SATELLITE NAVIGATION:-**

Programme in satellite based navigation is under definition .In the India -European commission working group meeting held in 1995, The mutual interest in developing a Global Navigation satellite system based on the principles of inter-operability has been noted and both sides felt that a suitable working structure and necessory frame work should be established through descussions between ISRO and the European space agency, Eurocontrol and European commission.

2.3568 Education:-

## SATELLITE BASED EDUCATION

Satellite based training and Development of Communication Channel.

These have been successfully conducted using INSAT satellite during the last few years . They include imparting training and continuing education to adult education trainees, extension agricultural workesrs and farmers rural development functionaries ,UGC centrally wide classrooms viwers , open University counsellors and students , industrial worders banking staffs etc . All these experiments got wide acceptance from user agencies. A training and development communication channel of INSAT was dedicated to the nation in Fabruary 1995.

Educational programmes trransmited through satellite based television help to cover a large number of remotly located classrooms . Using such a network, specialised lectures can be delivered throughout the country at the same time. Almost real life class room can be simuleted by providing a talk back channel to tudents to interact with the teacher . This talk back chennel can be through terrestrial telephone lines or through a satellite.

satellite based educational networks have been planned in many countries. A satellite teleconfrencing based network has been considered in U.S in early eighteis with facilities for audio fascimile and computer communication. Kentucky educational television has started a satellite

based educatinal project .In this network students use computer keypad for communicating with the teachers using electronic mail system . SAC Allahabad has conducted a number of satellite educational cources in cordinatin with UGC ,IETE and other agencies with a few classrooms spread throughout the contry.

**2.3569 METREOROLOGY:-**

The meteorological imagery data of INSAT is processed and disseminated by the INSAT Meteorological Data processing system (IMDPS ) of India Meteorological Department (IMD). The 0600hours can GM (Greenwich mean Time) VHRR image derived wind data are put on the Global Telemommunication system (GtS) of the world Meteorological Organisation. The 0300 hours GMT full disc infrared pictures are being transmitted as radio fascimicle broad cast daily for reception in the neighbouring countries.

INSAT -1D satellite has provided 24,546 full dise meteorological images till october 1995. INSAT-2A has povided about 1,564 pictures and INSAT-2B 2,201 pictures since their launches in July 1992 and July 1993 respectively INSAT VHRR imageries are used by DD during news coverage and by Newspapers as part of weather reporting. At present repeatetive and synoptic weather systems observations over the Indian ocean from geostationary orbit are available only from INSAT system .

One hundred meteorological data collection platforms (DCPS) have been installed all over the country and at the

Indian Base Station Antarctica . The DCP services one provided using the Data Relay Transponders on board INSAT-2A and INSAT -2B .

## 2.36 SATELLITE REMOTE SENSING:-

Timely survey and management of the countries natural resources through remote sensing is a major national need.Aerial surveys for this purpose have been going on from the early twenties. A 1970 experiment in Kerala sought to extend this to include multispectraland multitemporal data.

The Govt of India realising the importance of oprationalalising remote sensing applications ,created National Remot Sensing Agency at Hyderabad in 1975.

Work on developing data reception , data handling and data processing software and hard ware has been going on for quit some time. A number of operational resource surveys have been carried, out covering agriculture,(land use,crop census), geomorophology, surface water resources petroleum and mineral resources, forestry, environment .

Before the launching of Indian remote sensing satellite, India was totally depend upone Land Sat and FRENCH SPOT for remote sensing applications.

The concept of remotesensing from space platfroms or satellites is too complax for the layman to grasp . Remote sensing have the powerfull capacity to provide information about our earth's surface.

remote sensing can be defined as obtaining information about

an object by observing it from a distance and without coming into actual contact. The remote sensing satellites comprises of three segments (a) Space segment (b) Senser system and (c) ground segments. India is one of the small list of countries which has all these capabilities .

In India, development of satellite platforms for acquisition of remotely sensed data began with Bhaskara Mission of late seventies . The Bhaskara satellites had a two S-band T.V payload for land application and a satellite microvave Radiomete (SAMIR) for Oceanographic ,atmopherec applications.

The Baskara programmers provided valauble experience and insight into a number of aspects . such as sensor system definition and development conceptualisation and implementation of a space platform, ground based data reception and processing, data interpretation and utilisation as well as issues related to the integration of remotely sensed data with conventional data system for resourse management .

Convinced of the capabilities and the inevitable role of satellite remote sensing in national development India embarked upon several joint experiment projects (JEP) with the active involvement of the user community for the optimal management of our network resources . Sebsequently, the National Network Resourses Management system (NNRMS), a unique organisational set up in the world, was established to ensure the most effective utilisation of remote sensing

technology by facilitating the estblishment of necessory space , ground and user segments as wellas the integration of the views of the administrators, decision makers ,technologists and user community. This resulted in succesful launched and operationalisation of IRS-1A in 1988. Compared to Bhaskara, considerable progress had been achieved in every aspect of the sastellite mission Subsequently IRS-1B and IRS-P2 satelites were launched in1991 and 1994 respectively . These missions have not only realised the primary objective to design , develop and deploy a three axis stabilized polar sun synchronous satellite carrying near state-of-the-art payloads, but also paved the way to establish and routinely operate ground based systems for space craft data reception,dissemination and analysis and mission control facilities ensuring the operationalisation of the programme on an end to end basis.

Developments in the state of the art remote sensing satellites have gone a long way in establishing ISRO's cordibility in the area of satellite technology. A signifecant step was achieved with the successful launch of the sophisticated IRS-1C on Dec-28,1995. Incorporating several advanced features , this satellite is designed to deliver a wide spectrum of services and is the most advanced in the civilian remote sensing satellite at present providig imagery of the highest resolution for the civilian remote sensing world market.

Cmmensurate with the developments in satellite technology and data availability considerable progress has

been made torwards effective utilisation of the available data for various applications Since the days of macrolevel assessment of cocunut wilt disease remote sensing application have come a long way in or effects towards sustainable resourse mangement Today this technology has been opoerationalised to cover diverse themes/areas such as forestry, agricultural crop acreage and yield estimation, drought monitoring and mitigation,flood monitoring and damage assessmengt,land use/ cover studies waste land identification and reclamation,water resourses development and management, ground water targeting marine resours survey, urban planning, mineral prospecting, enviornmental impact assessment and so on.

### 2.361 NATIONAL NATURAL RESOURCES MANAGEMENT SYSTEM (NNRMS)

National Natural Resources Management system (NNRMS) for which DoS is the nodal agency is an integrated resource management system aimed at optimal utilisation of country's natural resoureses by a proper and systematic inventory of resource availability using remote sensing data in conjuction with conventional techniques. NNRMS activities are cordinated at the National level by the planning committe of NNRMS which povides guidelines for implementation of the system and also oversees management in the country . The NNRMS activities are guided by six standing committees-Agricultural and soil , Bio-resourses, geology , ocean resources, water resources and technology

and training .

## 2.362 IRS-SERIES:-

The major elements of NNRMS encompass conceptualising and inplementing space segments with neccessory ground based data reception, processing and interpretation systems and integrating the satellite based remotely sensed data services . The IRS series of satellite was operationalised with the commissioning of IRS-1A, in March 1988. An identical satellite IRS-1B was launched in August 1991 to continue the serivces from IRS . The IRS series has been further enhanced by IRS-1C launched by the Russian rocket Molniya, IRS-P2 and IRS-P3 launched by India's own launch vehicle, PSLV. IRS-1B carries two types of cameras, LISS -1 and LISS-2 with spacial resolution of 72.5 meter and 36.25 meter respectively. LISS-1 has a swath of 148 km and the two LISS-II cameras have a composite swath of 145km IRS-P2 has LISS-II cameras similar to that of the IRS-1B.

Apart from the operational missions, another series known as IRS-P series is planned for launch by the polar satellite launch vehicle (PSLV) with specific objectives of developing low cost application specific,fast turn around time satellte payloads .The successful launches of IRS-P2 and IRS-P3 in this series have paved the way for concorrent use of operational satellite , IRS-1A/1B and IRS-1C and IRS-P2 and P3 data nationally as wellas globally.

### 2.3621 IRS-1C

2.362 IRS-SERIES:-

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and greenhouse effects . This would be dpossible with a mission for atmospheric application- ATMOS which will have spectrometer, sounder and defferent radiometers.

All weather applications with multifrequency and multipolerisation micro wave payloads both synthetic Aperture Radar and other passive insturments .These data sets could also be useful for soil moisture estimation application and oceanography studies.

Studies have been initiated to define the satellite and payload systems for the IRS continuation missions Design studies for the subsystems are being taken up.

The ISRO telemetry, tracking and command network (IST RAC) With its space craft control centre (SCC) at Bangalore, Lucknow, Mauritius and Bearslake, has the primary responsiblity to provide mission support to IRS satellite. During the year ISTRAC continued to provide TTC support mission operations and control services for IRS -1A ,IRS-1B and IRS-P2 .

ISTRAC is also providing support to initial and on orbit phase operations of IRS-1C . The major tasks of ISTRAC for the IRS-1C mission control are scheduling of space craft operation and execution of orbit and atitude manoeveors as per mission requirements , orbit and atitude determination scheduling. Of command operations as part of payload programming, house keeping data processing and heath mounititoring in real time space craft health data archival and data base management, space craft subsystem performance monitoring through trend analysis, co

IRS-1C the first satellite in the second generation of IRS series was launched on December 28, 1995 by the Molniya Rocket of Russia from baikonur Cosmodrome,Kazakhistan. This spacecraft has enhanced capabilities is terms of spatial resolution additional spectral bands stereoscopic imaging wide field coverage and a more frequent revisit capability than its predecessors. It carries a tape recorder on board for recording the data when data is not being transmitted in real time. IRS-1C has three cameras an board.

1- A panchromatic camera with a spatial resolution of 5.8m .Oprates in the Panchromatic region of electromagnetic spectrum . This enables the generation of stereoscopic imagery and improved revisit capability.

2- A Linear Imaging self scanning camera (LISS-III) operating in four spectral bands three in invisible /Near Infrared and one in short wave infrared .

3- A wide field senser (WIFS)-a course resolution camera with spactical resolution of 188.3m and covering inside swath of 810km.

IRS-1C will be followed by a similar satellite ,IRS-1D to be launched during 1997-98.

**2.3622 IRS-P3**

IRS-P3 was launched by the third developmental flight of PSLV (PSLV-P3). It has the following sensers for applications related to oceanography and vegitation dynamics .

a) Modular opto electronic scanner (MOS), Designed and

developed by DLR Germany is a 18- channel imaging spectrometer in visible infrared region. The MOS payload is optimised for oceanographic applications.

b) wide field sensor (WIFS) similar to the IRS-1C to study vegitation dynamics.

**2.3623 IRS -P4:**

IRS-P4 is scheduled for lauch an board PSLV-C1 during 1996-97. It will have on board an ocean colour monitor (OCM) and a multifrequency scanning Microwave (MSMR) Radio meter for oceanographic applications. Work on the design and development of the payloads and the satellite have been initiated during the year .

**2.3542 IRS - Continuation Series:**

Subsequent to the IRS-P4 lmissions are being planned to provide improved data service for resources managementand environmental applications . The thrusts of the IRS continuation mission are the followings

1) High accuracy resourse management applications for mapping the vegitation.

2) High Accuracy Terrain Applications:-

Where the emphasis will be on target identification, utilisation mapping and obtaining Digital terrian, Models of lens that zoom height accesary and approximately 1:4000 mepping .

3) Global change applications specifically for atmospheric constituents study,pollution study and mounitoring the ozone

ordination with various network stations and other related

agencies and fault detection, isolation and recovery in case of space craft emergenies.

Facilities for reception arching processing, product generation and dissenination of date from IRS-1C satellite have been established and successfully operatinalised . Data products includes standred products which are genarated after applying radio metric and geometric corrections, stereo products generated from across track PAN images, special products generated after further processing the standard products by /merging /extracting and enhancement of the data.

**2.37 Data Reception, Processing and Dissencination:-**

The National remote sensing agency (NRSA) at hyderabad continued to acquire, process and disseminate satellite based remote sensing data from India's IRS-1A, IRS-1B, and IRS-P2, U.S land sat-5 and NOAA and European ERS-1. About 17,000 data productrs including 14,000 from IRS in the form of black and white (B&W) false colour composite (FCC) and computer compatible tapes (CCT) geocoded products, folppy and catridges and digitally mosaiced data were supplied to the users during the last year.

**2.38 REMOTE SENSING APPLICATIONS:-**

Operational use of remote sensing data for resources survey and managements is being made and severl projects

of national relevance in diffrent application themes are being carried out . These projects are being carried out with active involvement of user agencies at central and state levels . While remote sensing data is being utilised to prepare thematic maps/information on various resources- ground water, waste land, landuse, forests, coastal water lands etc. The thrust is now towards integrating these information with convetional data sets towards genarating sustainable developments plants at the local level. The integrated sustainable development (IMSD) which aims at generating locale specific action plans for land and water resources development through effective use of space based remote sensing data merged with callateral socioeconomic data has been launched in 174 districts of the country Based on a detailed review of IMSD during the year 92 blocks have been specifically identifeid for generalisation of action plans on priority for integrated development of and water resources.

**2.381 Agriculture:-**

The pre harvest acrage of crops and production estimation (CAPE) using remote sensing data is one of the major project now going on and is being carried out in collaboration with state and central agencies. Data from IRS-1B and IRS-P2 have been used to generate timely information on the crop status in various states . The data from IRS-1C will further enhance the crope in terms of repetitively and spectral and and spatial capability to

descriminate crops made and several projects of national relavence.

2)2.382 **Droght Monitoring and Assesment:-**

Monthly crop and seasonal conditions reports at district and at sub district level have been genarated. Digitalisation of sub-district bounderies has been carried out.

Geographic information system (GIS) based agricultural drought impact charecterisation and validation of mandal level drought assessment through water budget over selected districts have also been studied .The level of rain fall and crop yield has also been caried out.

3) **2.388 Flood Risk Zoning and Damage Assesment:-**

The floods in the rivers were monitored and mapped in near-real time using satellite data showing the post flood river configration will enable to plan flood control measures .Effects are being made to develop automated procedures for near real time flood mapping . As part of this digital topographical map base has been developed Satellite data is integrated with corresponding map base of the area in a GIS enviornment and map and damage statistics are generated automaticaly.

4) **2.384 Irrigation Management:-**

Programme for monitoring of irrigation, multi year satellite data have been analysed to assess improvements in system performence in Bhandra Poject, Hirakud-Mahanadi

projects, Priyar-Vaigai and cauvery projects. have been initiated Multi-data satellite maps showing geographical performance of paddy veraities.

5) **2.385 Snow Hydrology:-**

Forcast on snow melt run-off over the Himalaya into the rivers ane being issued . Snow cover satellites have been generated for various elevation zones for development of a short term run-off model. Most of the studies have been carried out in the basis of Satlaj and Beas.

6) **2.386 Forestery and Grassland Mapping:-**

Remote sensing date has been used to identify forest encrochment especally on the fringes of Sanjay Gandhi Nationl park, Mumbai. Forest density mapping of the park had also been carried out using IRS data showing that more than half of the park area in under closed forest. Biomass estimation in natural forests during both direct and indirect methods has been attempted for satellites in U.P using IRS-B data. With the satellite data, prospects in invasion rates, grass decline rates, salinity images rate, cattle consumption needs and above ground biomars can be estimated.

7) **2.387 Environmental Application :-**

Environment protection training and research Institute at Hyderabad a project has been initiated for genaration of qualitative and quantitative information on vegitation and land cover pattern, forest cover. The barren island volcano has been manitored using satellite data.

**2.388 Geo Sciences:-**

The satellite data can be useful for the study of minerals and mining areas,

**Wetland :-**

The project envisages mapping and inventory of inland and coastal wetlands in the country using IRS data including water spread, qualitative turbidity, aquatic vegetation and land use/land over.

**2.389 Marine Fisheries:-**

Identification of potential fishing zones (PF2s) using given surface temperature (SST) data is an important activity related to ocean resourses servey . Based on the persistance of the thermal features for a period of 3-4 days, PFZ forcast is disseminated aming fishermen . Dissemination of the forcast has also been started through T.V.

**2.3810 INTERNATIONAL MARKETING OF IRS DATA:-**

The IRS programme is the most robust remote sensing constellation planned and has the capabilities to fully meet these market needs. The IRS programme designed in the context of India's dedication to sustainable development combined with its experience in operational remote sensing, will provide a reliable contineous stream of high quality data. Just as the U.S land sat and the French spot

programmes have served as the backbone of International remote sensing in the past, the IRS in the next quarter centuary.

In the commercial spaces market, remote sensing is one of the fastest growing International commercial markets. The gapid growth is a result of the convergence of technology trends in computer processing and storage, Global positioning of satellites (GPS), and geographic information systems (GIS). The advances in these technologies are creating ever increasing demand for the kinds of information provided by remote sensing data.

In 1993-94 EOSAT commissioned an research firm to assist in the implementation of a marketing study that would identify marketing targets with the greatest market potential. The results of the study have been used to identify target market strategy for the sales and marketing of IRS products. The satellite imagery data segment can be broken into at least 16 different broadly defined market, oil and gas, environmental utilities, urban planning, forestry, geology/mining, hydrology, agriculture, mapping, oceanography, real estate, media and entertainment, insurence, health, low enforcement and militery defence .

To seccure rapid market acceptance and market share for data from the IRS constellation, the initial priority has been to establish capability to recive and process IRS data in the developed markets of North America and Europe.

Once acquisition and processing capabilities have been estabilished throughtout the International ground station

(IGS) net works, the next objective is to make the IGS's IRS data archive of meta data and quick looks available for review by the International user community throgh an on-line system.

The space activities in India are mainly thrusted towards satellite communications and satellite based remote sensing. The objectives pursued over the last few decades are gradually being realised. The development and successful lauch of the Indian Remote Sensing Satellites (IRS) have estabilished the fact that we have come of age in the space technology.

## 2.4 LAUNCH VEHICLE TECHNOLOGY:-

India prensently has the capability to lauch even launch vehicles which can carry geostationary satelite like GSLV. Starting with the development of small sounding rockets for upper atmospheric studies, a programme for the development of a satellite launch vehicle (SLV) was decided upon during the late sixties. A well defined time bound project for achieving a specific launch vehicle- the SLV, was initiated in 1973 and a 35 kg satellite Rohini, was orbited successfully in July 1980.

With the available Industry base and infrastructure in the country achievement of even a modest launch capability was quite difficult. Almost all of the technology elements such as propellants, propulsion system, avionics, control and guidence system, telemetry and telecommand system, special chemicals and material reliability engineering had

to be developed and perfected in house.

Sriharikota, about 100km north of Madras, has been developed as the country's principal rocket and satellite launching station. A nation wide tracking network for operational support to natinal satellites has also been estabilished .

The launch vehicle senario in India is mainly based of two factors.

1) The present status of launch vehicle technology in India and the space programme of the country. Now India has indigeneously developed Augmented Satellite Launch Vehicle (ASLV) to put satellites into low earth orbit (LEO) polar satellite launch vehicle (PSLV) to launch Remote sensing (GSLV) to put INSAT type of satellites.

## 2.41 Satellite Launch Vehicle (SLV):-

The development flight of SLV-3 was successfully conducted form "SHAR" in July 1980, which put the 40 kg "Rohini" satellite in near earth orbit. Later the other vehicles of the same series SLV2, SLV-3 was launched. The SLV-3 was put RS-D2 into the orbit.

## 2.42 Augmented Satellite Launch Vehicle (ASLV):-

The ASLV project, sanctioned in 1982 aims at the development of a vehicle, capable of placing 150 kg class satellite in near earth orbit. ASLV is basically configured with SLV-3 as its vehicle augmented by two strapons also derived from the SLV-3 first stage moters.

The first of ASLV project, ASLV-1 was blast off from the coastal range of Sriharikota. It was a failure programme. Later the successful launch of ASLV-D3 and ASLV-D4 has clearly demonstrated the viability of the configeration and the reliability of the ASLV vehicle. The two flights have generated valuable data or launch vehicle technology especially in the areas, control, guidence, structure, pyrosystem and circulating sensors and their caliberation integration techniques for the use in bigger vehicle like PSLV and GSLV.

**2.43 Polar satellite Launch Vehicle (PSLV):-**

PSLV is a major launch vehicle project for the eighties with solid and liquid stages configured to place 1000 kg class IRS satellite in polar sunsynchronous orbit from 1988 onwords. The left off weight of the vehicle will be about 276 tones with a height of 44meters. Out of the these PSLV programmes two were successful. The success of PSLV ended India's dependence on Rassian Vehicle to launch IRS space craft .

The experiance got from the three tests (PSLV-D1)PSLV-D2,PSLV-D3) shows the full capacity of the launch vehicles.

The continuation programme of PSLV has been approved for three more flights. The technology effects have been to standaredise products of PSLV systems, improved the payload capacity of the vehicle and increase the frequency of launches.

The launch of PSLV-D3 is an important mile stone of

ISRO. The state of the art PSLV-D3 placed a IRS-P3 an experimental remote sensing satellite into polar sun-synchronous orbit from the Sriharikota range on March 21,1996. This indigeniously prepared PSLV marked a new concept of market these launches Internationaly.

Technologically the PSLV is a quantum leap over its predeccers and the successful launch has catapulated India into the slect group of major rocket launching countries. The most important satellite segment that the PSLV can serve in the emerging market for low earth orbiting communication satellite. In this geostationary orbit the sastellites orbites the earth in much closer. These LEO COMSATS are intended to provide Global mobile technology.

## 2.44 GEOSTATIONARY LAUNCH VEHICLES (GSLV):-

Self reliance in rocket launching capability can be considered complete with the geostationary launching vehicles capacity, for launching INSAT-2 class of satellites into geostationary transfer orbit. This launching was intended to take place during 1997-98. This lift of a weight of 400 tones, the 50 meter tall GSLV is a three stage vehicle. The first stage has a 129 tonne solid propellant moter similar to PSLV with four liquid propellant strap on motor each carring 40 tones of propallant which are derived from the PSLV second stage. The second stage is also a liquid propellant stage carring 375 tonnes prepellants as in the case of PSLV. The 3rd stage is a rest artable cryogenic engine carring 12 tonnes of liquid oxygen

and liquid hydrogen.

## 2.5 SPACE TECHNOLOGY AND INDUSTRY:-

Space technology depends heavily on a combination of advanced technology and the development of spacecraft launch vehicles and associated ground system involves many scientific and technical desciplines . In the advance ment of this programme a concious effects has been made to estabilish close link with industries. From the early eighties ISRO's involvement and interaction with the country's industrial sectors has expended by an order of magnitude. Today these are expended by an order of magnitude. Today there are numerous industries licencees of ISRO developed technologes, comprising small, medium and large scale industries working subcontractors for the various satellite, launch vehicles project.

Technologies transfered industries have also largely benefited by the innovative schemes operated by ISRO such as technology transfar and the technological consultancy scheme, seeking to diffuse the expertise available in various areas within ISRO to the industrial sector and other R and Developmental institutions in a wide range of disciplines. The disaster warning recievers and data collection system for flood monitoring, Polyamides and polyamic acids or electrical and thermo insulation. ISRO GIS for rural marketing, high purity silica for use in rubber tyre, and pharmacecutical industries, agrophotometers

in process industries such as tea for moisture control, are some examples of ISRO technology being put into innovative use.

**2.51 ANTERIX CORPORATION:-**

With ISRO coming of age in the field of space technologies, the corner stone ofits future roll will be in the developement of an advanced space infrastructure continuing to mature the spirit of exploration and providing commercial exploitation of space.

Considering that almost 60 to 70 percent of the cost of any space product in value added services involving extensive engeneering hours for testing and qualification and with the considerable expertise built up in the country, it was imminent that ISRO enter the global arena to compete in the International market for providing space products and services. The establishment of an autonomous Antrix corporation by the Government is a major step taken to facilitate international marketing of Indian space capabilities and expreties using the resources of both ISRO/DOS and Indian Indurtry.

One of the Antrix's objectives is to emerge as a development and service provider, using the expertise built up over the successful comletion of the study proposals and development of antenna for the INMARSAT-P hand held phone. Training and consultancy is another area where Antrix has been sussussful is aquiring contracts from newly developing space nations such as Brazil, Malasia, Korea etc.

The second initiative consists of efforts to sell

access to the IRS satellite world wide as well as sale of data/ imagery from IRS. There has already been some notable success in this direction Antrix has teamed up with earth observation satellite company (EOSAT) of the U.S for the distribution and marketing of data from IRS constellation of the satellites including IRS-P2,P3 and 1B and the sophistecasted IRS-1C for the use of the international remote sensing community.

These companies together have been entered into business arrangements with ground station operators in different part of the globe to facilitate reception and distribution of data from IRS sastellites in the disignated territories. The first ground station out side India to start recieving IRS data has been the one in Norman, Okla Homa, U.S; which has been doing so since mid 1994. Antrix and EOSAT will also corporate in the field of providing infromation on data products and value added services.

The next step will be to enter the world market for launch vehicles. The PSLV success is a major step in this derection. With GSLV stated become operational by the end of this decade, the GSL market should also become accessible to Antrix.

## 3. CONCLUSION:

Adhering strongly to the goals of self reliance and sensitive to apply the technologies developed to social

applications, the Indian space research organisation (ISRO) has evloved into a multifaceted and multiprogramme oriented organisation and had taken up the responsibility to continue space application serivces to the nation in field telecommunication, meteorology and natural resourse management. The ISRO has ambitious plans to develop more advsnced satellites in remote sensing and communications. Another goal is to gain significant autonomous capability in launch vehicles for placing India's applicatin satellites into orbit.

India's foray in satellite technology began with the launch of indigeneously developed experimental communication satellite, APPLE in 1981, followed by the operational multipurpose communication satellites, mamely, the INSAT-1 series. Follow on services in the totally indigeneously built INSAT-1 system established India's mastery over state-of-the-art satellite technology.

A major success was recorded in the launch of INSAT-2C on Dec 7, 1995. This satellite holds the future ;lans and aspirations for the satellite communication world. To widen satellite use, Doordarshan is working on a nunber of new developments, news gathering equipments bothportable and vehicle mounted, business communication, data networking etc. These are the plans for INSAT-2D, and 2E. Inshort there is much that is hapening on the satellite communication front, a full future ahead.

Another mile stone is the development of the Indian

remote sensing satellite, the IRS. The IRS 1A and 1B lunched in 1988 and in 1991 respectively are providing remote sensing data with regard to agriculture, drought and flood monitoring, land use and resource management besides urban planning and forest management and surveying. The National Remote Sensing Agency (NRSA) in Hyderabad processes and distributes the data.

Before the INSAT and IRS phase, India was involved with Aryabhata , the country's first satellite launched in April 1975, and Bhaskara. These were not state-of-the-art satellite, and we come ahead since then." Apple" and "Rohini" followed."SITE," Satellite Instructional T.V Experiment, one of the largest of its kind for mass communication was experimented.

Another vital chapter is that of launch vehicle. Backe in July 1980, the first satellite launch vehicle (SLV) was launched successfully, since then the ASLV (Augmented Satellite Launch Vehicle) has also be experimented. The changes made in to the launch of PSLV. The latest in the series of launch vehicle is geosychronous launch vehicle (GSLV), whose first flight will take place in 1996-97.

In 1992, department of space started, the "ANTRIX" corporation limited to supply space products and services. The Bangalore based Antrix entered into an agreement in October 1993 with a company called EOSAT in the U.S, to market IRS data internationally.

IT is some basic issues that are now shaping space research prorities in India. Food, water and population

control thruogh education are among the most significant ones. A total understanding of our land, soil and water to feed our huge population, the meteorological parameters and the forests are necessary to produce more food. Space research will give, rather, it is already giving us answers about what is called "Carrying capacity of land "

It is not difficult to see the high points of progress, India has made in this tough and complicated scince, where crors of rupees are spent as a matter of routine. Yet the space programme has to fulfill the dreams of Sarabhai and Homi Bhaba. Space research has come a long way in this eventful 30 years and it's future streches ahead-bright, wast and full of meaning for India.

# *Part two*
# *Annotated Bibliography*

**SPACE RESEACH.**

1) DANIEL (RR).Space science in India: Present status and future prospects.Bulletin of Indian physics association. 13,2; 1982, June;50-5.

Describes the historic background of space science in India starting form the atmospheric science studies it passed through geomagnetic, space meteorology, remote sensing, astronomy, solar system studies, building spaceplatforms, communication systems etc. So many Rockets were launched from various space centers of the world. Highlighsts the plans and prospects for the eighties, like developing launch satellites of about 800 kg, Improving satellite telemetered data serviecs stations, space application centres at Allahabad, National Remote sensing agency at Hyderabad . Concludes that India has a bright future as far as developments in space research are concerned.

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2) SATYANARAYAN (S).India's Space programmer:The chellenges and social benifit.Economic Times. 14,247; 1987, December; 3a-f.

India'a space programme in the correct global context has significant in the sense it symbolises the countries ambitious bid, since independence, to become a

technological leader among developing countries . India's attempt to meet the objectives of development of communication for educational and developmental process and the management and survey of the countries national resourse began with the setting up of TERLS at Thumba successful launch of the SLV-3 in July 18, 1980. And a 35 kg Rohini satellite into a LEO. The efforts to develop indegeneous satellite and lauinch capability, particularly latter depends as the ability of the industrial abnd technologtical infrastructure in this the country to provide the neceasary support in terms of hard and softwares that would be required for the purpuse.

**----------, APPLICATIONS**

3) RAO(UR). Space for susatainable development.Journal of Space craft technology. 5,1; 1995, January; 1-10.

Introduces the concept of integrated sustainable development and bring out the role of space technology, through synthesising its two different applications via Remote sensing and communicati8on these contend to meteorology, T.V broad cast, education, environmental pollution, desatster mitigation,flood and ddrougjht management, virtually touching every fact of human endeavour . With the help of planning commission and active participation of user departments, 142 districts in the country have been taken up under the integrated study programme. The experience gained from the implementation of this strategy in the selected districts of the cuntry has demonstrated the

efficacy of this method.

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4) JAGANNATHAN (VP). Deep space navigation: An overview. IETE Technical reviw.11, 4; 1994, July- August; 194-204.

Presents a bird's eye view of deep spcae radio/optical navigation in the solar system. The regulated functioning of the spacecraft and the ground support systems are reviewed. Broadly, it outlines the inertial navigation of the launch vehicle, trajectory determination of the space craft through Doppler tracking, link budget, technology trends and limitation and illustrative mentions about a few odysseys.

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5) RAJ( Gopalar N). ISRO explores export market. Hindu Survey of Indian Industry. 4; 1994; Sec II, 144-6.

The world space market is one of the most carefully controlled, and ISRO, had better have a good market penetration strategy. Having successfully put up two operatinal multipurpose communication and broad casting satellite and also two remote sensing satellites, the principle interest of ISRO is the world sastellite market. India putting in all efforts to seize a share of the world space market. To realise this the ISRO is working out a strategy to be able to follow it vigourously: It is trying to join up with big players and trying to get sub contracts.

----------,----------**PRODUCTS, ANTRIX.**

6) RAMACHANDRAN (R).Space related products: ISRO turns to export market. Hindu survey of Indian Industry. 4; 1994; Sec III, 141-3.

Department of space established a seperate public sector company ANTRIX corporation limited to export space related products and skills. Space products and services need considerable skilled manpower. The ANTRIX is and interface between the foriegn buyer and Indian suppliers. Many foreign countries and industries were approached ISRO or ANTRIX to transfer the technique of PSLV to put the earth communication satellite for in whole world.

----------,**INDIGENISATION.**

7) SUBRAHMANIAN (TS) India's Space Odyssy: Steady climb in Indigenisation. Hindu Survey of Indian Industries. 1; 1991; sec 59-242.

The year 1991 is and eventful decade for ISRO.ASLV, PSLV, will blast off from Indian soil. There willbe some modifecation in the vehicle from the previous one. Points out the private sector role in making the PSLV. The design and configeration of GSLV is well advanced and highly classified cryogenic engine technology. Also highlights the importance of IRS-1A. The emergence of INSAST, revolutionalised the Indian communication system. Now ISRO is puirsuing the concept of 'GRAMSAT' to spread

literacy in the rural areas. It cost 60 caroes.

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8) MADHAVAN (R) and LAXMINARASIMHAN. Indigenesation of space electronics components. Journal of space craft technology.

6, 2; 1996 July; 140-5.

ISRO is contributing to the development of the mation through space based services like remote sensing meteorology, communication, destance education and information disemination. The Indian industry has contributed signficantly in the realisation of the mechanical, chemical, growth sub system required for space projects. Indigenisation of electronics components have been insisted upon in relent years to ensure the participation of the national electronics industry by supplying electronics components have been used in the IRS- P2 and IRS-P3 satellites.

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9) ARAVAMUDAN (R). Electronics parts Quality management for space programme: An overview.Journal of Spacecraft Technology. 6, 2; 1996, July; 132-8.

Current space programmes demand electronic parts in the a very high degree of reliablity combined with high package densities, reduced weight, reduced power conception and longer operating life. Now it is the age of electronic technology. Looks at the established selection criteria of high reliability components and tries to project the likely senerio in the immediate

future, inthe regard to its applicability to space programme. In ISRO the eletronics developments took place in two fronts. One was to use the MASA/ESA techniques with minor modifecations. The other was to become self reliante in electronic components.

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10) SAMPATH (N). Indigenous equipment and systems. Current science. 68, 7; 1995, July; 325-30.

Guided by the two objectives of self reliance and development - Oriented applications of space technology. The ISRO and Department of space have been consciously pursuing technologcal innovations in the wide range of disciplines. The efforts taken by ISRO/DOS towords realisation of its goal in the remote sensing are desribed. The role played by industry in the successful transformation of ISRO/DOS technologies into market - acceptable products and in the development of the market itself is also explained.

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11) SAMPATH (N) Indian space programme: On the road to self reliance. Hundu Survey of Inustry. 5; 1995; sec I, 131- 139.

The Indian space programme began with the primary objective of acheiving self reliance in space technology requirment for national developmental goals in terms of telecommunication, broadcasting, maturel resourses management and meteorology. The development and successful launch of the IRS and multipurpose, telecommunication, broadcasting and meteorological

satellite have established the fact that India has come of age in space technology.

**----------, RADAR COMMUNICATION, MICRO WAVE, METEOROLOGY, CYCLONE WARNING, INDIAN EAST COST.**

12) TYAGARAJAN (PN). Anomalous microwave propagation study using multisation cyclone warning radars in the Indian east cost: Indian journal of Radio and space physics.

25, 6;1996, June; 157-160.

Steep changes in the meteorological conditions particularly in the coastal ranges usually cause anomalous propagation of microwaves and seriously effect the performance of radars and other microwave compaign was conducted during the mouth of 1982 in which S- band pulsed cyclone warning meteorological radares situated at Karnataka, Madras were used for and studying the occurence of super refraction on and dictating. The above study of long distance anomolous propagation indicates that the super refraction and dicting conditions all along the coast of Bay of Bengal are not indicated.

**--------, ROCKET.**

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Gives, general introduction to India's space activities and ISRO's programmes. It prints out the technological development in ISRO especially the Rohini sounding Rockets. Chared with the

responsibility of supplying a large numbers of rockets for the Monsoon experiment of the global atmospheric rsearch programme VSSC has successfully launched 182 met rockets during 1979. On the launch vehicle scenario, the success of SLV described. The bottom lime in ISRO's launch vehicle programme is self reliance.

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14) UDAIYANATHAN (V) and NATARAJAN (R). Cryogenic in Rocketry Indian Journal of Cryogen: 9, 2; 1984; 77-90.

Deals with the specification, material of contruction, storage and handling techniques and sefty procedures for cryogenics propellants. The propellant can be stared using vessels insulated with high volume, multiple layer, powder rigid form etc. The insulation safety procedures and medical bulletins are also narrated.

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15) NARAYANA (K). Ground support systems for rocket flights. Bulletins of the Indian physics association.13, 2; 1982, June; 36-44.

The activities related to the flight testing of sounding of rockets and satellite launch vehicle, satellite mission operatins are highlighted in this paper. Sounding rocket flight are conducted for upper atmospheric investigations such as ionospheric studies, X-ray astronomy, monsoon expriment programme etc. Satellite launch vehicles are multistage guided rockets. Both the space craft's

operation and preparation have been described. Also the space craft mission are also been described in this study.

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The rocket soundings have helped scientists to understand circular processes in the atmosphere and in constructing models of the atmosphere. A rocket launching station was established in Thumba in 1963, which formed part of the meteorological rocket network in the equator regions of the eastern hemisphere very close to Indian ocean. An historical back ground of emteorological rockets have been desribed. With corporation of Indo-Soviet rocket sounding programme, various rocket sounding were carried out from TERLS. The useful for weather enalysis, but also for meteorological support ot rocket and satellite launching.

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17) NAIR (Sudhakaran). Climatology of the atmosphere up to 30 km over Thumba. Indian Journal of Radio and space physics.

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Regular observation of the meteorological parameters of the middle atmosphere using rockets have been made from Thuma. Since April 1967 to 1992. The

long term mean pattern of the wind components and temperature as well as their monthly variations are studied. The prominent wave components present are identified and their amplitude and phase as well as their cycle to cycle variations are brought out. Also the variations of the annual mean temperature are worked out and vertical profile of these variance presented. The mean wind and temperature structure and charecteristics of the quasi- biennial, annual, semiannual oscillation in winds and temperature up to 30 km agree with the earlier trend in the troposphere over Thumba. It is also seen that monthly mean temperature around 18 km are warmer by about 5km from the annual mean during the peak of the tropical at about 15 km.

**----------, ----- AND SATELLITE, DATA, AERONOMY AND ATMOSPHERIC STUDY.**

18) SUBBARAYA (BH). Rocket and satellite borne optical instrumentation for aeronomy and atmospheric science studies. Indian Journal of Radio space physics. 23, 2; 1994, February, 96-100.

The significant role of rocket and satellite borne optical instrumentation in the aeronomy and atmospheric sceince research is reviewed here. Begnning with rocket measurments in the reflects and sixtees of the solar UV and EVU Spectern using rocket monochromats,optical insturments has played an increasing role in the study of solar spectrum,

atmospheric structure etc. The major developments of the last two decades-middle dsatmospherics sciences as a distinct descipline over a great deal to satellite borne data analysis techniquies, Image processing and computation techniques together with developments of suitable platforms have played key role. In recent years several sophisticatedoptical techniques have been developed in India and are in operating use for ground based research in aeronomy and atmospheric sciences. These have potential for application from space plate forms.

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SRIVASTAVA (TN) and NANGIA (A K). Rocket rendezvous at preassigned destinations with optimum exit trajectories. Defence scientific Journal. 30, 4; 1982, April; 303-12.

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OBEROI (Chanchal). Friendly space. Science Reporter.

33, 1; 1996, January; 12-8.

Takes back to early history of communication methods to the present senario with the dawn of space age and space technology, it has made feasible to place sophisticated space systems swith applicationfor the benefit of mankind and society. The communication and navigational satellites revolutionalised the world. The remote sensing satellite gives us the view of earth by which we can imag merge the earth's land resources and enviornmental resources. In this article the various satellites launched by different countries are discussed. The issue in this paper is the magnetic desturbances, make use communication system go away.

21) ----------,-----, **APPLE.**
PRAMOD KUMAR and KARNIK (RS). What Apple means? Science Today. 15, 7; 1981, July, 63-5.

A space craft designed and developed by ISRO was put into the sky toy Ariane passenger the Kourou space centre in France. Apple is an important step in the country's satellite communication programme. The basic objective of Apple has been defined as building and getting launched an experimental body stabilised geostationarysatellite with its own apogee propulsion, attitude and orbnit central system and obtaining experiance in orbit raising and in orbit management. Among the experiments planned with apple are T.V transmission. Computer inter connection railway informations, banking transactions, facsimile transmission of newspaper are being descussed

here.

22) -------, ----------,-----.
RAO (UR) and VASAGAM (RMV). Apple seeks its slot in space. Science Today.15, 9; 1981, September; 65-8.

The first step after the injection of APPLE, the geo-stationary communication satellite is the testing of the reception of telemetry signals from the satellite downline and the station of the command uplink. The report of this is invisible in the SHAR within an hour of the launch. The second step was to determine the line of sight distance to the satellite using onboard UHF transponder. The third step is the determination of orientetion of APPLE in space. These are 3rd and fourth steps for apple which has been described here. This article also been described the manyfold advantages of a communication satellite to a country like India in providing telecommunication services with minimum dependance or terresterial links.

23) ----------, -----, -----,**LAUNCH.**
SALWI (Dilip M). Apple launched Science Reporter. 16, 7; 1981, July; 354-356.

On June 19, 1981 India's first experimental communication satellite APPLe was launcheds by the European satellite APPLE was launched by the European Ariane rocket form French Guyana into the circular orbit. This is and check up flight of INSAT due for launched 1982. APPLE has been designed, fabricated and tested with 3 1/2 years at ISRO center base and uses at TVM. APPLE was

eventually placed in its Scheduled parking slot over sumatra in Indian ocean. The Indian postel and telegraph department in collaboration with ISRO would use the satellite. Some Indian institutes of technology are planning to conduct a satellite communication course by using the satellite. It is also be used to collect meteorological data.

------, ------, **APPLICATION.**

24) DESAI (PS) and JOSEPH. satellite observations for the study of global change.Indian Journal of Radio Space Physics. 23, 2; 1994, February, 101-102.

An overview of the potentialities of satellite base. Observation for the study of global change for geosphere-biosphere interaction is given. Besides a general global discussion special focus is placed on the problems on impacts likely to be faced by the Indian region in particular. As the global change unfolds itself over the next few decades to a centuary. Some of these problems are impact of deforestation, green house warming and of aerosol on monsoon etc. The required observations to study these aspects and the satellite sensors and platforms planned for these are discussed .

----- ----- ------ ------, **EDUCATION DISTANCE.**

25) BALA (ML) and BHARATI (Manju).Distance education through satellte. IETE technical review. 11, 2 & 3; 1994, March-June; 174-176.

Education has been the most vital resourse for the development of any society. The destance education using

satellite cummunication is perhaps the best mode of transmission of lerns, since it can povide two- way auto-vidio links. The operation using the C-band earth station and lkthe satellite INSAT-2A have been given. After the necesssary signal processing in the satellite, the down link sighned transmitted by the satellite transponder os recieved by the direct reception system located at6 the remote class rooms.

---------, -----, ------- , **EDUCATION - DISTANCE.**

26) PAVATI (TV). Role of satellites in the promotion of Distance Education. University News. 24, 42; 1990, November, 8; 83-5.

Modern technologies and space research are yeilding very good results in imparting some awakening amongst the mass of the population. A new era has started with satellites and thier applications in various human activities. National and innternational TV networks has revolutionalised in recent years which enable to telecast live programme all ovr the world.

-------,----, -----, **METEOROLOGY.**

27) DESAI (PS). Satellite meteorology. Indian Journal of Radic Space Physics. 24, 5; 1995, May; 255-9

Describes the uses of data from meteorological and oceanographic satellite for meteorology. An attempt has been made to distinguish between operational and experimental, (R&D) uses, emphasise is placed on the letter, with a view to bringing some current and outstanding researchpoblem to the notice of university and research institution. Operational uses are very

brifly touched upon Research efforts are furthe sub disded into those using data from MET satellites, (ERS-I) where only limited data sets may be available. Developing applications from those latter type of satellites, may let demand for similar Indian satellites. The INSAT & NOAA data are being deployeds to obtain useful input towords the forcast models, suchas divergency vertical velocity field, sea surface wind in sun glitter area, air sea heat exchanges, cloud height and thickness aerosol optical depth over ocean and oil moisture on large seal finally it is suggested that, preparation work is called for, totake optional use of tuture INSAT-2E.

---------, ---,--- , **METEOROLOGY, ATMOSPHERIC MONITORING.**

28) MAINI (AK). Satcom : Weather patrol and atmospheric monitoring information technology. 4, 9; 1995, July; 59-66.

The importance of examination the earth and the atmosphere surrounding it from space with instruments such as high resolution cameras, radiometers etc, was quickly appreciated by advanced countries. Focusses on the role of weather satellites, the typical paylaods on board these satellites, the important international satellite systems meant for the propose and finally the futuristic developments that are likely to take shape in years to come. With advent oif computers, satellites can show pictures contain latant imformation about cloud data, about position extent and intensity of frontal

depressions, thunderstroms, hurricanes, sea breeze circulation and so on . This article also disusses the various mateorological satellites launched nationally and Internationally.

----------,---------,--- ---- -------, **STUDIES.**

29) PANDE (PC). satellite borne microwave radiometry for atmospheric studies. Indian Journal Of Radio Space Physics. 24, 5; 1995, May; 245-54.

Satellite microwave radiometryresearch contributions, mainly in the field of atmospheric science and ocean air studies have done in India, using data from India as well as foriegn satellites Geophysical parameters such as precipetabnle water, wind speed, sea surface temperature, precipitation temperature profile and humidity profile can be obtained from imcrowave radiometers with useful accuracy required for weather forcasting, climate studiesand physical oceanography applications.

-----, -----, ----,**CLOUD DATA, MANSOON, SOUTH-WESTERN.**

30) MISHRA (DK). Some aspects of south west monsoon as seen in satellite cloud imgery.Mausam. 42, 3; 1991, May; 261-4.

Satellite cloud imagery for the year 1978-79 and 84-88 have been studied here. Some aspects of south west monsoon has been shown that the cross equatorial flows, its location and intensity play an importent role in the on set of season. The southern hemisphere equatorial through plays the role in regulating the cros equatiorial flow and thus leads to the development of defferent

phases of south west mansoon. The inverse relationship between the intensityof southern hemisphere equatorial through and the monsoon activity can be used as a tool in for shadowing dry and wet spells. The results presented are helpful in understanding the physical process taking place in the monsoonal atmosphere.

--------, ----, ---, ----- , **SNOW MELT, RUN OFF STUDIES.**

31) UPADHAYAYA (S). Use of satellite based information in snow melt run-off studies. Mausam. 42, 2; 1991, March; 187-94.

Aims at evoluting a conceptual technique for the compitation of water yield from basin snow melt driven run-off particularly in the lean summer season. For this purpose the measurment of snow cover area in catchment of Satlaj river using high resolution imagery recieved from the meteorological satellites INSAT -B was undertaken an selected dates during the periods. The computed snow-melt water yield have been comparded with the available actual run-off data . The study shows that the satellite derived snows cover data are potentially useful in predicting the snowmelt run-off.

---,---,-----,----,**TECHNIQUES.**

32) RAY (TK). Advanced techniques in Meteorological telecommunication. Vayu Mandal. 25,3-4; 1995, July-December;57-65.

Describes various types of telecommunication system in Meteorology, the important being satellite communication. At 35,600 km above the earth's equatore geostationary satellites orbit the earth they provide communication,whose clarity and cost are not effected by

transmission distance. Various types of satellite community for providing instant communication without the use of any terrestrial links have been described here.

--------, --,----,----, **VSAT, COMMUNICATION, NETWORK, DATA.**

33) RAY (TK) and SINGH (SL). VSAT communication: A satellite bas communication system for reliable meteorological data exchange. Vayu Mandal. 24, 1.2; 1994, Jan-June; 26-30.

The new satellite application, known as very small Apertire terminals (VSAT) Technology is gaining ground world wide. Describes the features of VSAT network, nowbeing used by Indian Mateorological Department for colection and distribution of observational data and information. It is primarily a star net work with a central station at Delhi and operating with INSAT series of satellites in C-band transponder.

-----,-----, ----,------ **,WEATHER FORCASTING.**

34) DAS (PK). Future of weather forcasting in India. Science Today. 18, 5; 1981, June; 260-293p.

The prediction of weather leans heavily on how effectively we are sable to monitor the changes that take place in our atmosphere. Despite this difficulty, one of the encouraging features of the meteorological departments of India has been its ability to set up observing points over different parts of the country. The most advanced and progressive is the space meteorology. The polar orbiting weather satellite have been launched by USA and USSR, are fitted with automatic picture transmission facilities. Now India is trying to

develop such a polar orbiting satellite for providing the transmision from an advanced very high resolution radiometer to view the struture of cloud formation with much greater precision.

-----, ----,-------, **MILITARY.**

35) SAHAI (Baldev). Snooping satellites. Science Today. 16, 3; 1982, March; 14-20.

Ever since nations began formulation their foriegn policies, they realised that it was essential to have intelligence data for initiating a course of action in relation to other contries. Satellite are used for this purpose. More than seventy percent of the satellites launched so far are military oriented, and it is monopolised by two super powers, Russia and America. The role of these satellites is to observe the launching of international ballistic missiles. The French proposal for an intermational satellte monitoring agoney for developing countries like India.

---------,------, ------, **PHYSICAL SCIENCE.**

36) KASTURIRANGAN (K). Space and physical sciences. Current Science. 66, 10; 1994, May 25; 753- 62 .

With the advent of space exploration new windows in the electromagnetic spectrum namely gamma ray, x-ray and UV and IR region have opened up for detailed investigation of an space platform using satellite. Being a physist, the author use this opportunity to share the excitement of doing physices in the space way. Among the satellite borne experiment the capability of building and operate state-of-art satellite to meet a veriety of

complication has been established.

**----,------,------,TELETEACHING, DAMA SYSTEM.**

37) SHARMA (MA). DAMA syatem for interactive teleteaching via satellite.IETE Technical review. 11, 5-6; 1994, September-December; 35-9.

Education programme transmitted through satellites based television held cover a large number of remotely lacated class rooms. A demmand assigned Multiple Access system has been developed in satellite application center, Allahabad, specifically to manage the resourses of an education system talk back channel. The metwork description and the functional design of the demand assigned multiple access system for providing talk back facility for educational T.V programme are presented.

**----------, ----, ARTIFICIAL.**

38) BHATTACHARYA (AR).Artificial satellite: A new tool to study the earth Science Reporter. 15, 4; 1978, April; 224-227.

The year 1957 heralds the emergence of space age when an artificial satellite sputnik 1 was successfully launched by Soviet scientist. More nations are joning in the space race . The launching of artificial satellite is to under stand the earth, various point of view. There are various sastellites like earth resources satellite, landsat, symphony, Ariana, etc to use take satellite imagery rages for geologic studies and mapping of rock stratha to oceanography and survey of mineral resourses.

**----. ----,BHASKARA-II, METEORORLOGY, SAMIR DATA INDIAN OCEAN.**

39) PATHAK (PN).Study of spectral behaviour of microwave absorption by cloud liquid using SAMIR dataa Indian Journal of Radio and Space Physics. 20, 6; 1991, December; 402-4.

The Indian satellite Bhaskara-II carried a satellite microwave radiometer (SAMIR) operation at 19,22 and 31 GHz. In a recent study SAMIR data over ocean were analysed by the method of supervised classefication using NOAA-7 cloud imageries, and threshold bright ness temperatures for these SAMIR channels were determined for distingushing clear and cloudy conditions. In the present study, using these threshold values, SAMIR data over ocean for cloudy conditions have been operated and the spectral behaviour of the microwave absorption (emission) by cloud liquid water has been studied. The results of this study are found to be consistent with the theory .

----, ------, **COMMUNICATION.**

40) KALI SHANKER. Salient features of a communication satellite Science Reporter. 23, 4; 1986, April; 235-8.

Gives details about the communication satellite. It classefies into two types, ie Active and Passive. All communication satellite presently in use are active satellite. They have on-board electronic equipment. Using the passive satellite only one part of $10^{th}$ of the transmission power from ground was returned to the recieving ground terminals. The constructional features of COMSAT is also discussed, the various equipments to be used, type and size of propulsion system, interface of

satellite, with the launch vehicle etc. The details about +the antenna, transponder, spot beams and global beams, telemetry and telecommand subsystem etc are briefly described. Some example is being highlighted.

---- --- ------ ,**COMMUNICATION.**

41) RAO (UR). Development of satellite communication in India. IETE technical review. 8, 4; 1991, April; 191-96.

Satellite communication technology has opened up a vast spectrum of oppertunities which can tranform entire societies. The various steps in the field of communication in India has been described in this paper starting from the experimental launching of Apple to the new generation of INSAT-2 Series.

----,-----,-------, .

42) SUNDAR (S). Telecommunication through satellites. Telecommunication. 44, 3; 1994, June; 53-8.

The satellites are much in news nowadays. A layman does not have much idea about these satellites are now serving the mankind. An effort has been made in this article to describe the various aspects of satellite technology in such a way that even a layman may have feel of this field.

---,----,--- , **ANTENNA.**

43) UPSHAR (JI).1-W, Ku-band MMIC SSPAS for communication satellites phased- array antenna applications. COMSAT Technical reviw. 23, 2; 1993, April; 271-6.

The multibeam,Ku-band active phased-array antennas currently being developed for communication satellite requires broad band reproducible, and power effecient

solid state power amplifiers. Since these amplifiers will operate in multicarrires environment, they must be designed to meet a strigngent linearity specification while functioning at high effeciancy. The design and development of a fully monolithic 1-W, SSPA land the production of SSPA modules for a 64- element phased array antenna application are described. A summary of phase array antenna systems consideration is included. Methods should be extendable to the development of flight qualified SSPA for space communication application.

----,-----,-----, **BROAD CASTING.**

44) BHATIKAR (SD). and SRINIVASAN (N). Satellite broad casting: Present and future scenario. IETE Riview. 9, 3; 1992, May; 207-10.

Satellite broadcasting in India started during the last decade with the networking of terrestrial sound and T.V broadcasting transimiters located in defferent parts of the country. The phenomenal expansion of radio and T.V in the country both by population and area is the direct result of this networking. The relay of programmes originating at centralised locations through the satellite medium are of very high quality, reliable and costs effective compared to any other conventional means. They already started making great mipacts in broad cast satellites in this paper. The present seenario of Radio and T.V broadcasting and the future uses of satellite broadcasting in the country have been discribed.

----, -----, -----, **CABLE T.V .**

45) PANDHI (Vinit).Satellite and cable T.V Electronics for you. 28, 4; 1996, April; 59-61.

A decade ago, it was hard to imagine that the marriage of satellite and cable T.V would yield great scope in India. The large number of programmes being beamed to earth by satellite in a variety of langauge evry second of every day. Cable T.V and satellite home in India is 14-15 million today.

---,---,------,------ .

46) BHASKER RAJ (AS). Satellite and cable T.V.Electornics for you.26, 5; 1994, May; 55-56.

Apart from prociding detailed information on satellite communication. Includes a short note on India's successful developments and acheivements in the field of satellites and details of INSAT series of satellites which were indigeneously designed and fabricated by ISRO engineers . With the help of these satellites it is now possible to relay T.V programmes to more than 70% of our population.

---,-----,---, **CRYSTAL, OSCILLATOR.**

47) SHENOY (YD). Low phase noise temperature compensated crystal Oscillator. Journal of Spacecraft Technology. 5, 1; 1995, January; 22-25.

In telecommunication, navigation, data transmission and satellite communications, Signal sources with very low phase noise are required. Here, the definition of phase noise and its relation to crystal and transistor noise charecteristics are discussed. Degradation of phase

noise by frequency multiplication and its effects design of a low phase noise TCXO and the effect of the individual components are described along with the measured results. An 177.6 MHz low phase noise temperature compensted crystal oscillator is designed and fabricated imploying princples are described. The results are encouraging and provide state of art TCXO over a wide range of requencies from ten of KHz to 500 MHz.

------ ,---- ,---,**DIGITAL,TRANSMISSION.**

48) VANDAMME (P). Digital transmission techniques for spectral effeciency improvement of satellite communication systems. Journal of IETE. 36, 1; 1990, Jan-Fab; 41-9.

The probability of error performance of spectral efficient inter symbol and jitter free transmision techniques is evaluated for linnear and monlinear transversal recievers. These types of rcievers are suitable for digital satellite COM systems, particularyly for nonlinearly amplified power and spectrally efficecy lens compared with optimum binary schemes. The trade off between communication and spectral effenciency is also analysed. A novel binary transmission techniques having controlled ISI is introduced, which, without increased comlexity, improves the system effeciency. The obtained advantageous is significant for multi channels digital satellite communication system.

-----, ----, -----, **FREQUINCIES.**

49) BEG (Salim). Frequencies for satellite communication. Science Reporter. 22, 7; 1983, November; 143-146.

The fequincy spectrum of electromagnetic radiation of a range of frequincies used for wireless transmission of information from one place to another used for telecommunication, navigation, space research etc. The electromegnetic spectrum can be divided into a number of bands. Most satellite use UHF (Ultra high frequency), SHF(super high) etc. This frequincy bands is referred to as C-band. This article describes the various factors govenning the choise of frequency for space communication satellites. They are background noise, Range of communication and transmission losses, microwave interference band width availability, Antenna size, equipment availability and the economics of a satellite systems.

----------,--------, -------- **,FREQUENCY, CORRECTION.**

50) ARUMUGAM (G). New automatic frequency correction technique for narrow band satellite communication system.Journal of IETE. 40, 5-6; 1994, May-Aug; 287-90.

A new approach of an automatic frequency correction and technique for narrow band systems in satellite communication is presented. The proposed technique uses a digital frequency descriminator from the conventional descriminator, quite different from the conventional one which uses the well known phase lacked loop.

------, ------, -------, **INDIAN OCEAN GEGION.**

51) RAY (TK) communication satellite in Indian ocean region. VAYU MANDAL. 24, 1-2; 1994, Jan- June;9-11.

With the advent of satellite communication technology and its advantages over the conventional systems a rapid

and competetive growth of this communication systems is catching up in Indian ocean region. Describes the advantages of using satellite communication over conventional ones. Describes about India's INSAT'S series of multiprupose satellite system. The INSAT series of satellites provides multipurpose servises of telecommunication, T.V broad casting and meteorological series to the users of India and neighborhood. Altogether imples the developments of satellite communication in Asian-Pacific region.

----, ------, ------, **LAND, MOBILE,MODULATION, TEST.**

52) KHALONA (RA). Performence of M-ary FSK modulation in a shadowed land mobile satellite, Communication channel. Commsat Technical Review.23, 2; 1993, Fab-Aril; 225-235.

M-ary frequency shift keying (MFSK) is a power efficient Modulation scheme that is currently being studied for low power and low-data rate application via satellites. The power efficiency of this method increases as the signal alphabet increases, at the cost of increased comleplexity and reduced band width efficiency. The unloded performance of MFST in a land mobile satellite communication channels analysed using a channel model that includes the effects of shadowing. Results for coded performance using'Reed solomon coding' with hard division coding are derived and used to determine the codes that require the smallest signal to noise ratio for a given bit error probability and for varying degrees

of shadowing. These should be useful in determining link margins, and as reference for validating the findings of simulation studies.

---, -----, ----- , **MICROWAVE.**

53) DAS (BN). Advanecs in microwave communication and radar. Proceedings of Indian national science Academy.

62, 1; 1996, 61-76.

The improvement in communication and radar techniques for a mobile system by satellite has been described.Microwave signal is used for point to point communication and generation of narrow beam in radar system while VHF is used for point to point communication as also for broadcasting, coverage beyond the line of sight is obtained through relay station. After the availability of geostationary communication satellite,dish antennas mounted in towers are in use for transmission and reception of T.V as well as telephone and othrness. Communication with moving vahicle through satellite can be possible by mounting an antenna on the top of the vehicle, the antenna has to be continuously steered exactly in accordance with the changes in orintation of its axes to maintain communication link with the link.

----, ------, -------, ------, **APPLICATION.**

54) CALLA (OPN). Microwave application from space Journal of space craft technology. 6, 1; 1996, January; 1-10.

The electormagetic spectrum has many eyes or windows which could be gainfully utilised for defferent

application from space. These unique charecteristics have been utilised for global communication, broad casting, remote sensing and astronomy. Global communication can be established from the space using three geosynchronous satellite tremedous progress has been made in the area of satellite communication and the world has become a global village. Here a survey on the application of microwave and miltimeter waves in the area of satellite communication has been described with the space emphasis on Indian scenario.

**-----, -----, ----,MILITARY.**

55) CHATTERJEE (CK) and PAL (S). Present and futrue trends in military satellite communication system. Defence Science Journal. 43, 1; 1993, January-March; 37-42.

Gives an overview to the special features and future trend in military satellite communication systems. A brief account of various counter measures against threats, use of high frequecncy spectrom techniques and on board proccessing has also been given. Major technological advances are anticipated in near future to realise high capacity, sccure surviable satellite communication systems for defence application.

**---,----,-----,MOBILE, LEO CONSTELLATION, EQUITORIAL REGION.**

56) OLI (Sundar PV). LEO constellation for satellite mobile communication services in the equitorial region. Journal of Spacecraft Technology.5, 1; 1995, Jan; 64-70.

The crowding of GEO (geostationary orbit) are the inherit disadvantages of using GEO for mobile communication have forced the satellite communication

designers to look for alternative orbits such of LEO for mobile communication. Most of the constellation systems that are biased coverage of the U.S and the Europe where the traffic density is currently large. With the increasing demand for mobile communication in the equatorial region where most of the populous third world countries are located, a strong case exists for estabnlishing an independent, cost effective satellite mobile communications system for continuous coverage in this region. Suggests some constellation in low earth orbits to provide coverage for the equitorial region.

----, -----, ------, -----, **REGIONAL, SYSTEMS, MARSS-4A.**

57) ASHIYA (R). MARSS-4A regional satellite system for mobile communication. Journal Insturments and Electornic developments. 16, 3-4; 1995, August-September; 48-54.

Use of satellite systems in non-geostationary orbits for mobile communication is of wide interest today. Presents satellite system to meet the mobile voice and data communication requirements for users equipped with hand held terminals in rural and unshadowed areas of the limited regions of the globe bounded by 40N and 40's latitude. After analysing the effect of parameters which have dominant effect on the definition of space segment the coverage requirements to this limited region the overall system. World be much simpler to implement and manage. Finally the paper brings out how in comparision to the other system this scheme meets the system

objectives optimally with regard to both cost and complexity.

-----, ----, ------ , **NAVIGATION, WAVE PROPAGATION.**

58) SHARMA (AD) and CHAKRAVARTI (M). Wave propagation effects on satellite aided communication navigation and surveillance IETE Technical Review. 10, 6; 1993, June; 535-42.

Wave propagation effects on L and C-band frequences with respect ot satellite aided communication navigation and surveillance are discussed. Theoretical background on ionospheric and tropospheric parameters is presented using the available theoretical models. For typical conditions the propagation errors are estimated.

-----, -----, ----, **PAYLOAD, DEVELOPMENTS.**

59) SHANKARA (KN). Communication payloads: Present and future. IETE Technical review. 10, 5; 1993, May; 451-5.

Briefly reviews the technological developmental status of the communication payloads and also discusses the trends for the future developments. Payload subsystem like satellite antenna, multiplascing filters recievers and power amplifiers technology employed in INTELSAT and INSAT are described. Future payload concepts, technologies under developments are discussed with spacial reference to NASA'S advance communication technology.

------, ----, ----,**PERSONAL, GLOBAL.**

60) THOMAS (VA). Satellite system for global personal communication: Approaches, trends and the Indian

scenario. IETE Technical review. 11, 5-6; 1994, September- December; 279-90.

The coverage, spectrom utilisation, system reliability and cost of space based system in GEO, MEO, LEO orbits are considered and compared for global persenal communication system (PCS). Prospects for PCS in the Indian context are explored and a constellation of 18-24 small satellites in the low earth oirbits built and launched indigeneously is proposed as a cost efective means of providing PCS in India.

----, -----, -----, **RADIO BROADCASTING.**

61) KALI SHANKER. Radio communication on earth. Science reporter. 22, 7; 1983, November; 424-7.

The process of communication consists of a trnasmitter, a reciever and a medium. In radio transmission propogation medium is the atmosphere around the earth or outerspace. When the electromagnetic radiation passes through the space it looses the signal streanght. There are various parameters which effect the signal streanght. Evolution of satellite communications has a direct relationship with the parameter like the cavature of earth. There is only one repeater of microwave system, which could be put into space when put forward as most effective. Due to the curvature of earth, direct communications between two places cannot be maintained as electromagnetic rays travel in straight lines. This requires installation of large number of repeater stations between two stations.

Implimentation of satellite communication avoids this repeater stations.

------, -----, -----, **RADIO PAGING.**

62) RAMAN (NS) and SRIVASTAVA (UK). Satellite based Radio Paging. Telecommunication. 43, 3; 1993, June; 61-5.

In wide area paging a subscriber may have to be paged any where within the country. In a country of the size of India it will be extremely difficult to interconnect the number of base stations using line of sight radio and land lines. The satellite communication; due to its broadcast nature, prosess a satellite based paging network.

------, ------, ------, **RAIN ATTENUATION, SHILLONG.**

63) SARKAR (SK). IQBAL AHMAD, PRASAD (MVSN), DUTTA (HN). Rain attenuation on earth space path over shillong. IETE Technical review. 11, 4; 1994, July-August; 239-42.

The results on attenuation of radio waves due to rains in the frequency range between 10 GHz and 400 GHz over earth space path for satellte communication over Shillong is presented. Such results are derived by using the rainrate data obtained by a raipid response rain gauge and theoretical modelfor estimation of attenuation due to rain. The estimated results on attenuation due to rain over tropical station are underestimationed. The result provided these may be used estimating performance of satellite communication over north east region of India.

-----, -----, ------, **SIMULATION ALGORITHM.**

64) RAJESHWARI (PS). Simulation Algorithms for availabnility computation of a communication satellite constellation. Journal Space Craft Technology. 4, 2; 1994, February; 68-52.

Provides on alogrithm to compute the availability of constellation of satellites. The computation of availability of a constellation satellite is difference from a system which has a main element and its corresponding redundent elements. This is because the constellation as a total system has many main elements and the constellation charecterestics itself will hilp in providing reundency to some users while it may nhot be present for other users. These factors tend to make the mathematical modilling of the system max complex and impractical. An analysis on the out come of this algorithm even for a single constellation makes it voluminous since it consists of availability figures for farious users, for different durations and for various combination of the sparting philosophy replanishment strategy, reliaility of individual satellite, launch vehicle etc.

------, -----, -----, ------, **SYSTEM.**

65) KALE (P). Future space communication system for India. IETE Technical review. 8, 5; 1991, September-October; 865-7.

Currently the first generation satellite INSAT-1A is operationalised and is being used for telecommunication, Telemetery and sound broad casting and meteorological

observation including disaster warning. In future the sound generation satellites INSAT-2 series basically indigenously designed, fabnricated, integrated and tested by ISRO will be launched. The first of these is expected to be operational by mid 1992. These satellites will have large communication system capacity and wider connectivity for the network. In this study the requirements of the future satellite are brought out. The T.V requirment will include direct to community broadcasting state or regional networking National T.V networks, educational T.V networks, satellit news gathering, talk back system and vidio conferencing system. The telecom requirements include long distance thin and thick routes, information metworks, Rural telegraphic networks, mobile data networks and defence networks.

-------, ------, ------, **TECHNOLOGY**.

66) KALE (P). Future of space communication in India. Journal of IETE. 36, 1; 1990, January; 55-63.

Review's the space communications in the world as a whole. Future of space communication in general are deal with in terms crowding in space and some basic questions and their responses. Such as satellite obsolasence of both space and ground systems, sweeptibility of the communication to interceptions and intentional or unintentional interference attractive alternatives to satellites and technological dependence. Finelly the

future of space communication needs of India are highlighted in detail.

------- ------ -------, **COMMUNICATION, TECHNOLOGY, APPLICATION.**

67) PANT (N). Satellite communication technology and applications 1995-2010. Journal of Space Craft Technology.

4, 2; 1994, Fabruary; 1-28.

For a large country like India, as it enters the 21st centuary, communication will play a signifecant role in its overall development. Information dissemination plays a very importent part in improving human understanding and international relations. The concept of VSAT satellite series has emerged in India. This article gives and overview of the past present and possible future trends in the area of satellite communication Technology. The development involve fexed satellite network, captive network, digital satellite network and other sat networks like European networks, U.S networks, Indian network. Various other operational networkd like coal net, power net etc are also described INFLIBNET will connect all libraries of academic and research institutions of India. A fifteen year project from 1995-2010 has been made for a satellite system that should be needed to meet the country's requirments and would some extend meet external needs.

------, ------, -------, **VSAT, MESH NETWORK.**

68) GOEL (MK) and CHNDRA (V). Low cost VSAT satellite mesh network and proposed transputer realisation of sychronisation cicuits. Jornal of IETE. 36, 1; 1990, January-Fabruary; 81-87.

The link design for a mesh network using satellite has been given in this study. The need for synchronsation in the digital satellite communication is given. An outline of a software locked loop for implimenting the synchronisation and other base band circuts for a spread of ALOHA access very small aperture terminal is also given.

------, ------, **EARTH STATION.**

69) MOHANTY (N). Satellite earth station: Challenges ahead. IETE Technical Review. 10, 5; 1993, September- October; 469-73.

Use of satellite for telecommunication broad casting and remote sensing has led to new earth station technology developments. New serises and applications have thrown up chalenges to develop fixed, transportable and mobile earth stations with new divices/ materials/ production methodes. This paper brings stock of avilable earth station in the country and bring out areas of new Research and development and technological deveplopments to meet futre challenges.

------ ----- ----- ------ -----, **CONTROL SYSTEMS.**

70) ARUMOGAM (G) and YADAV (VS). Computer based earth station tracking chain simulator to aid the development and

evaluation of antenna control system. IETE Technical Review. 13, 2; 1996, March- April; 105-112.

Tracking of satellite by an earth station antenna has generally been required in situatins where the communication link specification dictates the recived and transmitted signel levels over the satellite link be maintainde within the specification limits user friendly software with graphic display facilities system simplicity sumultion reduces the integration and optimisation time of the traking chain, since most of the parameters can be in the laboratry itself . The simultor has been successfully can be used and antenna control unit developed for the international satellite monitoring earth station (ISMES),Jalna, India.

------, -------, -------,**CENTRAL HORN AND PERIPHERIAL HELKS.**

71) RAMALAXMI (V). Tracking few with control horn and periphe helics. Journal of Space craft Technology. 6, 2; 1996, July; 128-135.

Describes a simple few systems developed in the ISRO satellite centre, for a cassegrain antenna system for earth station radar application covering about 500 MHz band width at 5.65 GHz. This is similar to the usualfine low feed system but for the outer four forms which are replaced by a combination of helics. Helics have been chosen to replace theouter four houns for the advantage of simple hardware, reduced spacing between elements and the reduction in size and cost. An altempt is made to join two hilics at a single correctore for getting the

difference pattern to enhance th above mentioned advantages in addition to the inherit wide band charecteristic of a helical antenna.

-------, -------, -------, **DHERADUN.**

72) VARMA (Vivek). Dehradun satellite earth station Science Reporter. 15, 5; 1978, May; 316-8.

A geostationary satellite orbit around our planet and altitude of 36000 km above the equator. The large distance between the earth and the satellite weakens the signels, to over come this highly sophisticated technique is required. The setup should be able to gerate 6 GHz and recive 4GHz frequency such a set up is called an earth station. India had set up an earth station in pune in 1971. In 1977 a more efficient earthstation was set up in Dhradun valley. The capability of this earth station is being described.

------, -----, ------, **SIGNAL DISTRIBUTION.**

73) GARG (VK). Optical phase division multiplexed Transmission for stellite earth station signal destribution. Journal of instruments and electornics communication. 40, 4; 1994, April; 181-7.

The optical phase division multiplexed duplix transmission for satellite multicareer spectrum to and from earth station is described and investigated. The optical transmission band width for uplink and doiwnlink carriers are anlysed as function of number of carriers and phase devisation. Anlytic expression are given with and with out optical line amplifires.

----- -------, **GEOSTATIONARY, TIME COMPARISION, ACCURACY.**

74) BANERGEE (P). Accuracy of time comparision via geostationary satellite in a common view mode. Indian Journal of Radio Space Pysics. 24, 6; 1995, June; 339-89.

A detailed analysed relating to the users in the predictin of satellite co-ordinates to time comparison accuracy using geostationary satellite in a common view or differntial mode is presented the findings are derectly applicable in the use of satellite -T.V signal in a passive mode. With the present capability of prediction of satellite co-ordinates on accuracy better than 2-ms over India is expected. A comparision of the corresponding error in the case of time signal dessemination, via, satellite in one way mode has been made. Some experimental observations related to this has also be studied thoughly to corroborate the analytical findings.

------, ------, **IMAGES, CODING.**

75) JAGANATHAN (VP). Variable rate block interpolateve coding for satellite images. Journal of Instrumentation Electornics Telecommunication Engineers. 36, 1; 1990, January; 96-9.

While many image compression schemes have come up in recent years, a new scheme using two diamensional interpolation for satellite images is presented. This scheme is very useful for on board application since it achives resonable comparision with very simple

incoding and decoding operation. Also a scheme, namely block interpolative coding has the a facility for fixing the required compression quality and distortion. Simulation results on Indian remote sensing satellite image are also presented here .

**,-----,------, INSAT, AUDIO BRODCASTING, DIGITAL.**

76) SHARMA (MK). Digital audio broad casting through INSAT satellite. IETE Technical review. 13, 1; 1996, January-February; 25-27.

Direct audio broad casting via satellite provides large coverage areas and is most suitable for large countries like India. India has the advantage of higher look angles requiring less margins for mobile operation. Describes the scheme worked out for domonstration of Digital Audio Broad casting through the two S- band transponders for INSAT. Fixed location receptoion through small recever has been cheked via satellite. A portable reciver with detachable front and having patch array antenna has been developed the reciver can recieve any one of the transmitted programme channal.

**-------, -------, ------, COMMUNICATION, SOS.**

77) LOBO (Sylvistor). SOS by satellites. Science Reporter. 22, 10; 1988, May; 56-60.

The use of satellite for saving victims of air accedents and marine desaster as well as lost tractors is gaining currency among nations and India is the first among in the developing countries to join this. Tells us about the first veture developed by U.S, Canada in 1977, and is called SAR SAT, and 1982 USSR launched COSPAS.

India is planning to developed its own system using the second genaration geostationary satellite called INSAT-11A, 11B which will have special beacons transmitting in 406 MHz Frequency when this satellite aided search and rescue programme (SACR) becomes operational it would not only cater to ships and air craft in distress, but also to vehicles and mountainers.

-----, ----, -----, -----, **T.V BROAD CASTING.**

78) RAO (BSS) and SHARMA (BU). INSAT- programmes Developmental and Educational Communication Unit Conference of ISRO Allahabad. 26-28; 1984, November; 26-32.

The ministry of information and broad casting spent 68 crors to expand the television covrage up to 70% of the population of the country the T.V expansion scheme during $6^{th}$ plan. It was originally proposed to have one high power transmitter at Vijayavada. Later it became 12 transmitters. Thus the state, Andhrapradash has thus got full complement of this programme is the operation of its effective delivery system. Under the INSAT utilisation plan, the central government transferred the entire responssiblity of the execution of the community T.V scheme to state Government.

-----, ------, -----, **DIGITAL, SUN SENSOR DATA.**

79) KALE (PP). Extraction of Orbital Information from digital sunsensor data of INSAT Satellite. Journal of Spacecraft Technology. 3, 1; 1993, January; 23-30.

In order to maintain the station keeping maneuor by geostationary satellites, the satellite control centers creat data. For this porpose the technique implimented is

the scheme on board the satellite and hence achieve autonomy in space craft oprations. Explors the features of using the data of sun sensor (ISUS) on board INSAT-1 to drive the required orbital level information depending on the sensor mounting geometry, the data is available in certain season for certain duration of the day. Concludes that DSS data does not contain information about the orbit, and on involved and intelligent data processing, the information can be extracted. A simple methematical model of the sensor is developed on a Pc/AT using the sensor data for INSAT-1B and INSAT-1D satellites the capabilities and limitations of the methode are brought out.

-----, ------, ------, **EARTH STATION, MASTER CONTROL FACILITY.**

80) RANGARAJAN (S). INSAT master control facility: An insight <u>current Science.</u> 69, 9; 1995, September; 410-5.

The multiporpose INSAT satellite series has a well advanced master control facility centre at Hasan. The MCF is controling the multidimentional services provided be the satellites. Discribes the services of the INSAT series and the major subsystem of the space craft and thier inter relation ship with the MCF centre. Describes the facilities at the MCF and describes it as a multiple earth station co-located with mission control cente. If the MFC has been able to achieve smooth and flowless operations for all these years it is only due to the personal involvement. MCF has been responseble for

various innovations such as the survival of INSAT-1B through the eclips seasons inspite of the loss of both the onboard batteries.Concludes with the hope that it can intorduced newer payloads performing newer sereies in the future.

-----, -----, ------, **METEOROLOGY.**

81) KELKAR (RR) and GUPTA (HV). Use of INSAT of observation of communication of meteorological information. IETE Technical Review. 9, 3; 1992, March, 214-21.

The Indian National Satellite INSAT-1 is a multiporpose geostationary satellite providing meteorological, telecommunication and broad casting series. Describes a ground segment of the meteorological components of the INSAT system. The prosessing of INSAT data at the meteorological data utilisation centre, New Delhi is explained in detail. The complexities of satellite image prosessing and recording and collection of observations by unmanned meteorological platforms are described. Describes how the communication capabilities of INSAT are being exploited for transmission of desaster worning to costal areas under the tropical cyclone and the disemnation of meteorological data to the various forcasting centers of the India meteorological Department.

------, ------, ------, -------, **CLOUD DATA.**

82) PRASAD (O) and RAO (AVRK). Estimation of relative humidity profiles from INSAT-Cloud data. Mausam. 42, 3, May; 287-90.

Accurate humidity to profiles are needed for obtainig usefull forcast from numerical weather prediction models. This is estimated with the moisture profiles over ocean areas using satellite cloud data avilabile from INSAT. These cloud data has been classified into different categories depending on the total cloud amount. Thes data have been observed and estimated many places like port Bliar, Minicai etc. The preliminary results reported here show that the relative humidity profiles cloud provide useful information on moisture distribution in the vertical indian ocean . .lm1

-----, -----, ------, **PROGAMMME.**

83) NARAIN. INSAT programme. Journal of Space craft Technology. 4, 1; 1994, January; 1-16.

With successfull launch and operationalisation of INSAT-2B, the system has one of the largest domestic system in the world. The INSAT system deals with six major programmes. The need of geostationary satellite for broadcasting on programmes. This chapter takes us to the historical background of INSAT programme and the experiments carried out with AT-S 6 space craft under the SITE programme and with symphonie under STEP programme and APPLE space craft under APAI programme. The INSAT system completed ten years of services of the nation on 14$^{th}$ Oct 1993. INSAT-2A and 2B have opened the door to the next decade of sustained growth and service to the nation.

-----, ------, -----, ------, **HISTORY.**

84) VISHNU MOHAN and ASHOK RAJ. INSAT and India's space

programme. Science Today. 17, 1; 1983, Jan; 67-72.

The launching and failure in INSAT-1A, (April-Sept) made news all over India. The development of the concept of INSAT can be broadly catagorised in three phases. The first is the development of satellite communication from 1967-1971, in the II$^{nd}$ phase 1972-1975, the 3$^{rd}$ phase was from the satellite instructional T.V experiment. Also describes the evolution of INSAT mainly for introducing T.V in India in 1966, by Chandra commitee. At the same time Dr. Sarabhi conceptualised satellite T.V as a poweful toolfor meeting the educational informational and entertainmet needs of the rural population. INSAT as envisaged by the space scientists combined two large scale ventures, a major efforts in space technology and application of advanced communication policy which would be able to integrate all the aspects involved. .lm1

-----, ------, ------, **T.V BROAD CASTING.**

85) RICHHARIA (M). Satellite to Home. Science Today. 20, 7; 1986, July; 46-8.

The impact of telivision is now being felt in almost every home all around the world. Most of the cities in India have local broad cast stations. This is because of the aivailebilityof the Indian domestic satellite system INSAT-1B. The telivision broad cast from the INSAT-1B satellite can be recived at any location in India. Describes the new broad cast technology and its station in the national and international areana. Since the transmission is meant for communication between fixed points, it is illegal to recive the signals without

permission. The direct broad cast satellite system may be classified as telivision distribution type or direct to home type . The quality of both have been described.

------, -----,**INSAT-1B, APPLICATION PRODUCTION TELEVISION.**

86) GOEL (DR) and JAISWAL (Kiran). Educational Televisoin in India. University News. 24, 42; 1996, November 8; 8-10.

Describes the educational programmes through space. It has become possible through satellite such as INSAT-1B. The UGC has started telecasting special programmes of lectures for the benefit of veiwers during the day. Spacial channal utilisation and intraction with various Universities made possible. The INSAT-1C programme will facilitate distant education.

----------, ------, -------, ------, **METEOROLOGY.**

87) SHESHADRI (NS). INSAT-1B An eye in the sky weather. Science Reporter. 21, 1; 1987, January; 36-40.

When the satellite era comes, some three decades ago, meteorologist were quick to realise the potential satellite held for studying the atmosphere. Since satellite view the atmosphere from high altitudes, they can provided a regular supply of data from these points. With the aid of advance communication developed by satellite technology has developed the transmission of data rapidly to earth station. Review about the mateorological satellite especially INSAT-1B. It is a geostationary satellite. It has seprate channels meant for communication and T.V programme distribution for

direct telecasting in rural and national network and desaster worning. Also discusses the MCF, instrument specification etc. INSAT provides cloud imagery data. If severe weather such as a cyclone is signed any where. The satellite brings into action and sends out warning to the people likely to be effected. foreworning is far assuming is the motto of this eye in our skies.

-----, -----, ------, ------, -----, **DATA, THUNDER STORM.**

88) KALSI (SR) and BHATIA (RC). Satellite observation of development of thunder storm complexes in weakly forced environment. Vayu Mandal. 22, 3-4; 1992, Dec; 65-76.

An attept has been made to utilise the meteorological data from INSAT-1B for monitoring development of severe connection, especially in environment charecterised by weak synoptic settings. The meso-scale processes encountered in the Indian sub continent has been studied. It also describes about connective scale interection leading to the development of meso scale convection in gerneral.

------, ----,**INSAT-2, APPLICATION, METEOROLOGY, VHRR.**

89) JOSEPH (G). INSAT-2 very high resolution radiometer for meteorological observations. Journal of Space craft Technology. 4, 1; 1994, January; 183-203.

Discusses the use of high resolution Radiometer which is designed and developed indegeniously for meteorological imaging of the earth in the visible and thermal infrared bands in the geostationary orbit. These developments involve multidisciplinary skills and

technologies. Explains the VHRR design requirments, analyses and trade offs. Implimentation, ground and in-orbit test results. Two such VHRRS are now operational on-board INSAT-2A and INSAT-2B satellite providing weather data to the Indian meteorological Departments.

-------, -------, -----,**COMMUNICATION,PAYLOADS.**

90) SHANKARA (KN) and DEVENDRAN (S). Technological of aspects t communication payloads for INSAT-2. Journal of Space craft Technology. 4, 1; 1994, January; 175-82.

The INSAT-2 series of satellites have new features such as operation in extented C-band frequincy part from mormal C-band, high coross polorisation isolation over this center 'C'band to enable the co-location of satellites and the addition of a search and rescue data entry package. The Technological aspects of the major subsystems of the communications payload, antenna recevers etc are described in detail.

-----, ------, ------ , **CONFIGURATION.**

91) RAMACHANDRAN (P) and GOEL (PS). INSAT-2 Space Craft Configuration Technology and realisation aspects. Journal of Space Craft Technology. 1, 1; 1994, January; 16-26.

The INSAT-2 series is a multipurpose space craft. Their requirments were worked out taking into account the service to be provided by the space segment till the turn of the century. The payload consists of 18c/ext c-band transponderes, two S-band high power transponders for T.V and high resolution two band for meteorological data relay and search and rescue system. compatibility with multiple launchers, simplisity of the deployment,

avoidence of the partial diployments, animisation of wieght, optimisation of propulsion system accomodating the field of via requirments of theVHRR radiation cooler were the major constrainsts with the design of the INSAT-2. The new confriguation features that evolve are discribed. The configuration and the chosen technologies on the succes full realisation of INSAT-2A and INSAT-2B are hightlighted and the growth possibilites for the INSAT-2B are indicated.

-------, -------, ------, **DESIGN.**

92) NAIR (PS). INSAT-2 Space Craft Structure. Journal of Space Craft technology. 4, 1; 1994, January; 716-31.

structure and mechanical design of INSAT-2 space craft with emphasis in new structure are discussed here. The development and qualification of the structure involved are detaildly and experimently studied. The results of these studies bring clearly the behaviour of the space craft under static and dymamic load environment. The non linear behaviour of fuel tank support structure and the significant difference seen in lateral stiff ness obtained from analyses and experimental studies are of special interest.

-----, -------, -------, **MISSION PLANNING.**

93) BHUSHAN (YN). Mission planning, analysis operation of INSAT-2 sereis of satellite. Journal space craft technology. 4, 1; 1994, January; 209-216.

INSAT-2A and 2B have been successfully placed in geostationary orbits. The INSAT-2 mission activities

started along with the finalisation of space segment requirment and definition of space craft configuration. Generally the requirments planning, developing and establishing a compatible ground systems consisting of both hard ware and software elements proceded concurrently with space craft developments. The other importent task under mission planning, analyses is to interrelated and integrate the space and other ground segment configuration to arrive at a mission plan leading to the realisation of the mission. It also includes analysis of launch vehicle fuel budget estimation ground station visibility etc. Here both satellite mission is disscused. A comprehensive set of mission plans and procedures are developed to enable smoth conduct of operation on the satellite in orbit.

------, ------, -------, **POWER SYSTEM.**

94) MURTHI (N SRINIVASA). INSAT-2 power system. Journal of Space craft Technology. 4, 1; 1994, January; 35-58.

The new power system of INSAT-II are designed to meet the power requirments of the satellite during various phase of mission. The power geration is by silicon solar cell arry during sunlight period and during eclipse, power to provide to the batteries by Ni-Cd Batteries which are charged by solar rays. The power system is configured as a dual bus system regulated during sunlight period and unregulated during eclipse. Deals with the design, fabrication and testing features of each element of the power system namley solar array, batteries and

power elctronics a system applicable to geo synchronos satellite.

------,------,-------, **RADIATION SHIELDING, ELECTRONIC COMPONENTS.**

95) BHATT (BR) and SAHU (RP). Radiation shielding of Electornic components in INSAT-2. Journal of Space Craft Technology. 3, 1; 1993, January; 36-47.

Describes the effects of space radiation in the geostationary orbit, which degrade the edlectromic components of the space craft. 70 shield devices from radiation it is necessory to understand the radiation environment, radiation of threshold electronic components and the estimated does of the space craft. Taking all these data the space radiatios does expected to be recieve by the electronic components of INSAT-2 has been estimated here. Additional shield thick ness required to bring down the total dose below the radiation threshold dose to the components have been estimated assured for INSAT-2 (6.1 kg for space craft) form the radiation point of view.

----, ------, ------, **SENSORS.**

96) KAMALAKAR (JA) JAIN (YK) and KANAKARAJU (K).Sensor for INSAT-2. Journal of space craft technology. 4, 1; 1994, January; 95-114.

For the INSAT-2 series satellites, a variety of sensors are used at various stages of the mission operations. That is from launcher separation onwards till the satellite placed in the prefixed slot, for the measurment of thealtitude of the space craft. Briefly

discribes the various sensors used and thier flight perfomance on these satellites. To properly guided the space craft though the various phases and to bring it to the required orbit, the sensor plays a very importent role. The main sensor of INSAT-2A are new and it took five years to develop the various units. The development of sensor for the Indian communicatin satellite INSAT-2 is a challenging task, taken up buy the sensors team.

-------, -----, -----, **TT AND C TRANSPONDERS.**

97) MADHAVAN (KN). TT and C tronsponders for INSAT-II series satellite. IETE technical review. 11, 5-6; 1994, September-December; 291-6.

Presents the system design hardware realisation various qualifications tests performed and in orbit performance of the C-band Telemetry tracking and comman progrmme (INSAT-2 Programme). This transponder has been successfull flown in INSAT-2A, 2B space crafts. The system is used for telemetry, Telecommand and tracking data determination during transfer orbit as well as on-orbit modes.

------, -----, ------, **VHRR IMAGES.**

98) PADMANABHAN (K) and RAJAGOPAL (C). INSAT-2 space craft platform stability estimation using VHRR images on APC-based ISRO- vision system. Journal of space craft technology. 5, 3; 1995, July; 48-54.

One of the task envisaged during INSAT-2 mission programme is to estimate and monitor the platform stability of s/c using very high resolution radiometer images at MCF. To study the platform stability,VHRR

images are required in real time and small images of land/ water transition are extracted and they are matched with the next frames using images correlation. The VHRR images frames are tested with INSAT-2A VHRR data. A PC based ISRO vision system was obtained for image processing and display fucntions. The real time VHRR data was acquired using a 16bit parallel DMA cards which was designed and developed with necessory software implimentation in ISRO vision system. This procedure is used for monitoring the steability on a seasonal or monthly basis.

------- ------ ----- ----- , **THERMAL CONTROL SYSTEM, DESIGN.**

99) KAILA (VK) and BHIDE (RS). Design of thermal control system of INSAT-2A and its initial in orbit performance. Journal of Space craft technology, 4, 1; 1994, January; 132-44.

The thermal design of INSAT-2A is achieved by conventional passive thermal control Techniques augmented by ground command on-board leaters. 147 temperature sensor have been provided to monitor the performance of the TCS on board. The mathematical simulation models at space craft level and subsystem levels have been developed for designing and analysing the performance of TCS. INSAT-2A has successfully completed more than one year in its on-orbit operational mode and the performance of the TCS has been satisfactory.

----,-----, ----, ----, -----, **2B, PAYLOADS ASSEMBLY AND INTEGRATION.**

100) KATHI (VR). Assembly, Integration and testing of INSAT-2A and 2B. Journal of Space Craft Technology. 1, 1; 1994, January; 154-164.

The assembly integration and testing of the INSAT-2A class of space craft with all the associated complexities of on posed many challeges. The testing of large number of payloads transponders and complex house keeping electornics in differnt phases of the space craft development programme called for adopting automated techniques by an extensive use of main frame and pesonal computer system. Give a brife overview of the methodology adopted to overcome the challeges along with a concise account of anelyse mode hard wares desighed tests conducted and software developed for realing in this the specialised frame for the two space crafts during the configuration studies mechnical interface design, system integration launch vehicle interface defination etc.

-----, -----, -----, -----, -----, -----, MONSOON.

101) KELKAR. Application of satellite data in the study of monsoon variability. Proceeding of Indian Academy of Science. 271-81.

Disscussed the use of satellite for studying climatic change with particular emphasis on the interannual variability of the Indian South West mosoon. Precipitation estimates made from INSAT-IIB, radiace data are shown to bring out the variation that occunted in the monsoon rain fall of 1987 and 1988. Out going longwave Radiatin derived from INSAT-IIB shows good correspondence with precipitation pettern.

------, -----, -----, **INSAT-2C, PROGRAMMES.**

102) KHAN (HASAN JAVAID). INSAT-2C launched. Science Reporter.21, 11; 1996, January; 52-6.

INSAT-2C, the satellite that promises to carry forward the telecommunication revolution, sweeping across the country. Set in to its orbit 36000 km above the earth. The importance of INSAT-2C is that the functioning of this satellite will enhance India's telecommunication services like broad casting beyond the boundaries, communication between moving persons on land, sea and air. It was launched Arian launch vehicle from kouron in French Guyana on on $7^{th}$

December 1995. unlike other INSAT satellite the INSAT-2C does not carry a meteorological payload. It carries KU band transponders for telecommunication especially for data networking and news gathering. Aother service introduced by INSAT-2C is the mobile satellite services.

------, -------, -------, **IRS.**

103) KASTURIFANGAN (K). IRS Mission. Current Scinece. 61, 3-4; 1991, August 25; 136-150.

For a country of India's size and population, the necessity of generating continuous and up dated information on terrestrial resources and environment needs are very important for the planned development of the country. Recognising the importance of satellite based remote sensing systems for harnessing the natural resourses of India, ISRO has under taken the design and development of a sereis of Indian Remote sensing satellites(IRS) to provied remotly sensed data for application in the areas of agriculture, hydrology, geology, drought and flood monitoring etc. As a first step to this (IRS) launched since 1988 has been operationalised. Highlights the various considerations in deciding the mission parameters, sensors choice. Space craft main frame system and ground segment. Further it gives a brief account of the performance of IRS-1A system and the follow on satellite in the IRS series.

-------, ------, ------, -----, **APPLICATION, LAND USE, VINDHYAN RANGE.** .lm1

104) PANT (DN) and DAS (KK). Mapping of tropical dry forest

and land use in part of vindhyan range using satellite remote sensing. Photonirvachak. 20, 1; 1992, January; 9-20.

Forest vegitation of vindhyanrange located in the north of G.B Pant Sagar (Dam) has been subjected to degaradation of thermal power plants, coal minining, heavy cattle grassing etc. In the forest study land sat and IRS were visually analysed with respect to forest vegitation, crowd density and structure along with other land use or land coverage. The overall classificatin accuracy of the forest types has been found to be 88.94%. This indicates that for obtainiing reliable mapping accuracy in this area, satellite remote sensing department of appropriate season is essential.

-----, -----, ------, -----, -----,

**SEISMOLOGICAL.**

105) SRIVASTAVA (HN). National and International status of seismological observations over last 25 years.

Bulletin of Indian Society for Earth Technology.

30, 2; 1993, February; 61-70.

Deals with national and international status of seismoloical graphs linked with satellite telemetry which have been deployed by IRS series of satelites, also include other satellte data for the last 25 years along with regional networks which also would continue to provide the desired data for years to come. The gaps in this derection highlight the need for enclogenous capacity building.

------,-----,------,------, **DATA, REMOTE SENSING,**

**APPLICATION, AGRICULTURE, SOYABEEN, PREHARVEST, ACRAGE.**

106) VENUKANTARATNAM (L). Pre-harvest acreage estimation of soyabean using IRS data for production forcasting.

Journal of Oil Seeds Research. 11, 1; 1994, 76-80.

Contribution of soyabean crop to domestic production and to the national exchequer is increasing significantly year after year. The methodology and results obtaned in the experiment on preharvest acreage estimation of soyabean using remotely sensed data from Indian Remote sensing satellite IRS-1A/1B L1 sensor during 1991 and 1992 crop seasons analyses of remotly sensed data by adopting stratified random sampling and or complete enumeration methods. Pre harvest soyabean acreage could be satisfactorily estimated at 90% confidence level.

----,------, ----, ---, -----, **LAND SAT, REMOTE SENSING**

**APPLICATION, LAND USE.**

107) SHARMA (RC) and BHARGAVA (GP). Remote sensing for assessing the distribution and charecterisation of saline and alkali soil in Haryana. Agropedology. 3, 5; 1993; 95-103.

The images got from LandSAT and IRS on the salt effected area in Haryana has been described here. Both saline and alkaline soils having salt curst on the surface and also devoid of any vegitation cover were registered in a bright white tone of the image. The problem of saline and alkaline soils and the season for salinity and alkalinity have been described here. These problems are due to the improper soil water management

practices.

-------, -----, ------, -----, -------, **OPTICAL ALIGNMENT.**

108) TYAGARAJ (MR). Optical alignment method for Indian remote sensing satellite. Journal of Space Craft Technology. 3, 2; 1993, February; 38-40.

Indian remote sensing satellite (IRS) carries, three multispectral cameras, two types of earth sensors, a star sensor, a set of dynamically funed gyros and four reaction wheels require precise. alignments with respect to defined space craft areas and between themselves to meet mision goals. An alignment procedure based on optical instrument technique was developed and used to align elements on in space craft. An analysis of alignment procedure instruments, comparison of the ground measured and non orbit data are presented.

----, -----, -----, ------, ----, -----, **CROP INVESTORY.**

109) NAVAL GUND (RR). Crop inventory using remotely sensed data. Current Science. 61, 3-4; 1991, August,25; 162-170.

The physical basis of crop identification discrimination and estimating yield using spectral data is described. State of art crop inventory has been summarised. Development of methodology for acreage, condition assessment and yield forcasting using IRS data are dissussed. Result obtained for major crops in India using digital data from the IRS-1A are presented. The pre-harvest estimation of wheat, rice, cotton, sorghum,

oil seeds are promising and demostrate the capabilities of remotly sensed data from IRS-1A and other satellites. These studies relate to the chosen districts in various states with wide variations in soils, climatic conditions and management practices. Limitations of the techniques are indicated and scope for improvement has been outlined.

-----, -----, -----, -----, -----, -------, **GEOLOGY MINERAL RESOURSES.**

110) BHAN(SK). IRS-1A application in geology and minereal resources. Current Science. 61, 3-4; 1991, August 25; 147-250.

Mineral deposits are the products of the geological proceses where by namolus concentration of mineral environment. The data from IRS-A satellite ever since its launch in March 1988 has been extensively used in different geological and geomorphological applications.

------ ------- ------ ------ ---- ------, **GROUND WATER TARGETTEING.**

111) SAHAI (Baldev) IRS-1A Application for ground water targetting. Current Science. 61, 3-4; 1991,August 25; 172-178.

A large population in the world depends on ground water not only for drinking and domestic use, but also for agriculture and industry. Search for ground water, particularly in areas with consolidated and semi

consolidated rock formations, considered more difficult from the point of view of exploration is considerably aided by the use of hydrogeomorphological maps. prepared using satellite imagery. These maps depicts spatial information on various hydrogeomorphological units including structural lineaments having different ground water prospects. As exaples of hydrogeomorphological mapping, three case studies have been cited.

-----, ------, ------, -----, -----, ------, **LAND USE.**

112) RAO (DP). IRS-1A application for land use/land cover mapping in India. Current Science. 61, 3; 1991, August25; 153-159.

Land is the most important natural resource which embodies soil, water and associated flora and fauna involving the total ecosystem. Land use/land cover inventories are needed for the country. Remote sensing application with IRS-1A LISS-1 data helped generation of destrict wise land use/land cover maps for the whole country on 1:250,000 scale to serve the requirement of agro climatic zonal planning, initaited under the planning cmmission of the Govt of India. Both th visual interpretation and the digital classification technique were employed in mapping land luse/ land vover categories. Completion of land use /cover maps of 442 districts is record time of one effective year established the operational utility of IRS-1A data in land use/land cover mapping in an efficient and cost effective manner.

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**TERRAIN MAPPING.**

113) KUDRAT(M) and SAHA(SK). Land productivity assessment and mapping through terrain slop data. Journal of Indian society of remote sensing. 21, 3; 1993, June; 157-66.

Evolution and mapping of spatial variation of land productivity is very important for effective land use planning. The present study was under taken in water shed of song river. For assessing and mapping, use the modified storie index following integrated approch. This approach utilizes soil scape information from IRS-1A, for soil charecterestic and terrain slop information. The methodology for doing all these has been described.

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**URBAN MANNING.**

114) MURTHY (Krishna YNN) IRS-1A Application for urban planning. Current Science. 61, 3-4; 1991, August25; 243-246.

The urban or urban dependant population in India is very largly distributed in more than 3000 urban centres which are progresvly expanding in size and number. IRS data has been extensivly used in mapping and monitoring urban sprawl, urban land use, transport network zoning and demographic studies. Amongst the case studies presented in this paper, land use mapping in Nagpur city helped detetion of unauthorised construction and encrochment of slums and other residential areas on to good agricultural lands. Urban sprawl mappig of Srinagar city reveals onslaught of urbanisation on lacustrine environment. The accuracy of the results was

found to be of the order 91 percent.

-------- -----**IRS-1B.**

115) LAUDABLE ACHIEMENT. Economic Times. 31, 184; 1991, September; 4-6.

The images so far got from IRS-1B indicates that it performs satisfactorily. The need of IRS-1B become more vital if the user agencies make full use of space technology. Only a few advanced countries have such a continuing system of operationalised remote sensing. This is a major acheivement of ISRO. There are some problems in the infrastructure for analysing remote sensed data. This is critical for an efficient use of the data. Now the remote sensing is poised to enter the service and comercialised sector. It is an opportunity for India to fromulate space policy. Russian co-operation did so much in IRS technology. But we cannot depend on Russian, as the internal policy situation is undergoing changes. This emphasizes the urgency of having indigenous launching capabiliy in the form of polar satellite launching vehicle (PSLV).

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116) RANACHANDRAN (R). IRS 1B a milestone for Indian Scientists. Economic Times. 31,181; 1991, September; 8a-c.

The indigenously prepared IRS-1B India into the group of the few nations which have a continuing operational remote sensing programme. India's remote sensing programme has been an indigenous effort since its

begnnig. In remote sensing the objects on the ground is sensed identified and dilineated from a distance measuring the electromagnetic radiation of the sun that is reflected by the objects on the surface of the earth, and provides reliable and timely information. ISRO'S remote sensing on a contineous basis start with Bhaskara programme (1976-82) Now the IRS data have replaced American land sat and French SPOT. IRS-1R polar orbiting, sun synchronous satellite placed at an altitude of about 90km. The potentiality of remote sensing will be realized when demand comes from the user community.

------, --------, -------, ------, **ATTITUDE DETERMINATION.**

117) CHANDRASHEKHAR. Attitude determination IRS-1B satellite. Journal of Space craft technology. 5, 3; 1995, July, 62-73.

IRS-1B, the second in the series of IRS satellite is a three axis stabilised satellite, placed in a near circular, polar sun synchronous orbit at 904km altitude. Earth sensor, dry turned gyros and a linear array star sensor are used for post factor based altitude determination. Attitud determination using star sensor consists of data prosssening of processed and raw star data. The methodology of earth sensor based attitude determination consists of data preprocessing,modelling and compensation of systematic erros due to eath's obleteness as well as variation.

-------,------, -------, **REMOTE SENSING, APPLICATION,**

**GEOLOGICAL STUDY, DAL LAKE.**

118) WANI (MM). Quantification of suspended solids in Dal Lake, Srinagar using remote sensing technology. Photonirvachak. 24, 1; 1996, January; 22-30.

Inian Remote sensing satellite IRS-1B, linear imaging self scanner (LISS II) Spectral digital data was analysed to determine the feasibility of quantifying the concentration of suspended solids in the surface water of inland water body, Dal Lake in Srinagar. The water samples collected in current with IRS-1B overpass, were analysed to determine the concentration of suspended solids the result indicate that a polsible functional relationship exist between the concentration of suspended solids and the visible wave lenght bands 1 and 3 and near infrared band 4.It is concluded that IRS LISS-II data can be effectively used to qualify suspended sediments concentration in the Dal Lake surface water.

**------, ------ , IRS-1C, DATA PROCESSING AND QUALITY EVALUATION.**

119) HEBBAR (Jairam K). Data processing system of IRS-1C and quality evaluation. Current Science. 70, 7; 1996, April 10; 534-550.

The department of space recognised the need for harnassing space technolgy for various appliction and acquired state of art capabilities in the develoment and establishment of operational remote sensing satellites. Considering the success of IRS series sofar the department of space took up the development of IRS-1C

satellite. The national remote sensing agency at hyderabad, recieves and procesed data from remote sensing satellites, Including IRS-1C. This article gives detalils on the entire processing facilities including filming, Photoprocessing and quality control facilities and also gives a detailed account of the various systems both hardware and software. Data quality elevation has also been dealt seperately.

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**RECEPTION SYSTEM.**

120) ANIL KUMAR and SARMA (TC). Data reception system for IRS-1C. Current Science. 70, 7; 1996, April 10; 534-40.

Data transmited try IRS-1C satellite are recieved at earth station at Shadnagar near Hyderabad. This sophisticated data reception complex works in a multimission mode supporting data reception from sevral remote sensing satellite like IRS series and Land sat and ERS. Describes the various elements in the data reception chain. The specification of various station is also discussed complete data flow from the time , RF signal is piked up at antenna and till it is recorded high density digital tape is explained at sub system level. Data archival and real time system is also explained giving details about "O" procesing of data. Requaired test facilities and system margins desirable are also given apart from necessary infrastructure. The information management system are networked in the satellite real

time system at Balanagar.

----, -------, -------, --------, **MARKETING INFORMATION**

121) EDWARD (David T) and CARY (Tina). International marketing of IRS-1C data. Current Science. 70, 7; 1996, May; 638-641.

The global market place is seeking affordable, high quality digital data to displace other technologies, to augment existing data and to support innovative new applications currently under development. The IRS programme is the most robust remote sensing constellation planned and has the capabilities to fully meet the market needs. In this article. The past experience in the international remote sensing of U.S land sat and French spot have been discussed along with the future programmes of IRS data marketing. That is this paper provides a brief overview of Global remote sensing market. The IRS satellite imagery data segment can be broken into at least sixteen diffrent brodly defined markets like militory, oil and gas, forestry, geology, agriculture etc.

-------, ------, ------, **PCM.**

122) RAO (UR). Conputer aided techniques for the realisation of the diaphram of the PSM for the IRS-1C.

Journal Space craft technology. 4, 2; 1994, Feb; 43-50.

The Indian Remote sensing satellite system,

IRS-1C is configured with a pay load steering mechanism to orient its panchromatic camera system, which has a resolution of 10U for remote sensing application. The PSM is designed with a leanear force deflection behaviour, exactly compliant member, nemely the diaphram optimisation of this diaphram was carried out using CAD tchniques to obtain a low arrial stiffness of 10 kg/m.m and a very high radial stiffnese of more than 10,000 kg/m.m and explains in realising the design optimisation and maniy lecturing methods in realising the diaphram for the PSM application.

--------, --------, -----, ------, ------, **PLANNING, AND OPERATION.**

123) SHIV KUMAR (SK) SHARMA (KS) PATTAN (RAM) and GUPTA (KK). IRS-1C mission planning, analysis and operation. Current Science. 10, 7; 516-522.

The IRS-1C mission planning activities began with the payload choise as per mission objectives derived through users requirements. Detailed mission specifications elements of the mission after detailed mission analysis. The mission planning activities involved integrating and inter relating the efforts of both space and ground systems which would provide the comtinuity of satellite based remote sensing data services in India. The world referencing schemes for all payloads have been design to enable users to specify the required data. A knowledge base and graphical representation of spacecraft subsystem

base and graphical representation of spacecraft subsystem are some of the new features introduced for space craft health analysis. Since details of the space craft operation carried out in the launch and early orbit phase and also on the perfromance of the space craft subsystems in orbit.

-------, ------, ------, ------, **REMOTE SENSING.**

124) BALAKRISHNAN (Manjule). S Patil success. Down to earth. 5, 17; 1996, Januray 31; 5.

With the launch of most advanced remote sensing satellite IRS-1C the ISRO Scientists aim to invade the world market for satellite data. Points out the features of IRS-1C and its sophisticated equipments which have been prepared indigenously. The equipments are the force panchromatic camera to take the picture of a particular area in two positions, LISS (The linear imaging self scanner and WIFS( wide field sensor). Also describes the cost accounts of IRS-1C.

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125) KASTHURIRANGAN (K). INDIAN REMOTE SENSING Satellite (IRS) -1C. The beggnning of a new era. current Science. 70, 7; 1996, April 10; 495-500.

The various advantages of remote sensing satellites effectively help us to make use of available natural resources that has been in many parts of the world. Their capability to provide inevitable range of

information has made this space technology an important tool in the development and utilisation of natural resources. IRS-1C which is the latest addition in the array of IRS has the capability to compete with other satellites of the world. The major attraction of IRS-1C is its capability to provide high resolution data and more frequent coverage. India started its remote sensing programme with Bhskara mission in 70's. Later in 1988 IRS- 1A, IRS-1B and IRS-P2 satellite were launched in 1991 and 1994 respectively. IRS-1C has been operationalised to cover mean such as forestry, agricultural crop acreage, drought monitoring, flood monitoring, landuse over studies wasteland identification and reclamation, urban planning, water resources management, environment impact assessement etc. It's mission is not only to design, development an deploy to the polar sychronous satellite but also to establish a ground based system for space craft data reception, dissemination and analysis and mission control. IRS-1C supplies data to national level through national and regional remote sensing agency and to international level by establishing network in various parts of the country.

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126) RAO (Radha krishna). Another satellite in orbit. Science Reporter. 33, 4; 1996, April; 49-50.

The second generation IRS satellite IRS-1C marked a milestone for more that three decads old Indian

satellite programme. The 1250 kg- three axis stabilise IRS-1C is developed by ISRO. It has the capabilities in terms of spatial resolution, re-visit capacity. The IRS-1C will give further boost to the integrated mission for sustainable development. This aims at integrating remote sensing data obtained from satellites with data obtained through conventional means. Having found IRS-1C data to be as good as the data provided by LAND SAT and SPOT EOSAT has set up a direct reception ground station at Norman, Oklahoma. the future plan of IRS-1D is also mentioned in this article.

----------, ------, ----, -----, **APPLICATION, CARTOGRAP**

**TERRAIN MAPPING.**

127) SRIVASTAVA (PK). Cartography and terrain mapping using IRS-1C data. Current Science. 70,7; 1996, April; 562-566.

IRS-1C satellite provides multispectral LISS-III and high resolution steerable panchromatic data for cartographic applications. The updation of topographic maps will be one of major applications of the data. Gained a theoretical assessment of the potential of IRS-1C imagery and the early results from few sterio pairs. For moderatily undulating terain sterio pairs with B/H of 0.5 a moderate radiometric contrast, the elevation information derived from IRS-1C imagery is sufficient for 1:25,000 scale mapping. 1:25,000 scale maps could be reidentified and registered on the imagery.

----,----,----,----,----,**COSTAL ZONE, MANAGEMENT.**

128) NAYAK(Shailesh). IRS-1C applications for coastal zone management. Current Science. 70, 7; 1996, April 10; 614-618.

IRS -1A and 1B data have been found to be useful in providing information on extend and condition of coastal habitats, processes and water quality of coast waters. These inputs formed major elements for preparing coastal zone management plans. IRS-1C data having improved spacial resolution camara (PAN)and increased repetivity camara (WiFS) .

-------, --------, --------, ---------,--------**DATA, PRODUCT.**

129) HEBBER (Jairam K). IRS-1C data products genaration an dissemination. Current Science. 70, 7; 1996, April 10; 551-61.

The success of a satellite launch depends on the usage of satellite data. The usefullness of satellite data, inturn, depends to a large extent, on way in which data are achieved, prosessed and distributed. The NRSA data cetre, Hydrabad is responsible for supplying the satellite data products to various organisations both in India and abroad.

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**ENVIRONMENT, TAMIL NADU.**

130) RAMASAMY(SM) and BALAJI(J). Aid of remote sensing in mapping geofractures of environment significance in Tamil Nadu. Journal of space physics. 23, 2; 1994, February;109-18.

Geofractures play a crucial role in environmental degradation and environmental pollution. The study shows that mostly N-S and NE-SW rending fracturs are prone to seicmicity and pollutant migration while NE-SW and WNW-ESE trending faults are prove to soil erosion. Further shows that mostly the quarternary fractures lineament are having a dominent control over such phenomena.

---------- ------- -------- -------- ------- -------, **TARI BHABAR BELT.**

131) AGARWAL (CS). Role of remote sensing in Demarcation of Alluvial Fan Deposits in Tarai Bhabar Belt National District (U.P) and the environmental impact assenssment. Journal of the Indian Society of Remote sensing. 24, 1; 1996, January; 62-68.

Remote sensed data has unique advantage over conventional data collection technique in the study of geomophlology, as physiographical and geo-structural parameters are mostly descriminable on the imagery. In the present study an attempt has been made to evaluate the process of geomorphological evolution and hydrological conditions using multi data satellite data of IRS (1993) suggests that the ground water utilization in Tarai belt may lead to total failure of flowing well and subsequently disturb the balance of ecosystem.

----------, --------, ------, -------, --------, **FORESTRY.**

132) ROY(PS) IRS-1C data utilization for forestry applications. Current Science. 70, 7; 1996, April; 606-613.

The IRS-1C satellite with its sensor onboard has the immense potential to provide information on forest resourse on thier survellance and monitoring. Towards this the early results on the use of high temporal wide swath WIFS data for repid forest maping have been demonstrated. The data from LISS-III and capability for 1:25,000 scale froest cover mapping amply demonstrate the potential of IRS-1C for effective monitoring of forest resourses. The use of WIFS data for fire monitoring and LISS data for assessing

afforestations and defroestations have been discussed. The PAN data for microlevel studies have been found adequate and discussed in this article.

--------,-----,------,--------,------, **GEOLOGICAL AND GEOMORPHOLOGICAL STUDIES.**

133) RAO(DP). Use of IRS-1C data for geological and geomorphological studies. Current Science. 70, 7; 1996, Aril;619-623.

Remote sensing technology has opened new vistas in geological mapping and related studies. The data from the earlier stellite like LANDSAT, SPOT, IRS-A and 1B had limitation of spatial resolution restricting their usage mainly to semi detailed studies. The better spatial resolution data avilable from IRS-1C launched recently on 28 Dec 1995 will be quite useful in detailed mapping and studies. Highlights the advantages and capabilities of WIFS, LISS III and PAN sensor data of IRS-1C conjunction with appropriate ground truth information for geological application.

--------,------,-------,-------, **GIS.**

134) RADHAKRISHNAN(K). Enhanced geographic information application using IRS-1C data. Current Science. 70, 7; 1996, April; 629-632.

The tools of geographic information system (GIS) which can be used in a rapid urbanisation to address the local problems of rapid urbanisation have been dissussed. With availability of high spatial

resolution data of IRS-1C, many new ways of looking at urban utilises and environment have been ilustrated. The new GIS models which can be adopted on operational basis by developing and linking data bases in spatial and non spatial form down to cadastral level have been explored. Day to day problems of the urban dvellings, ie, traffic and transportation, grenery, solid waste dispostal, pollution of new lay out for uraban growth road alignments etc, have been give a new look under the GIS environment with posssibilities arising from the high resolution colour images of IRS-IG satellite.

------, -----, -----,------ **GIS, URBAN UTILITY, MAPPING.**

135) RADHA KRISHNAN (K). Enhanced geographic iformation system application using IRS-1C data potential for urban utility mapping and modelling. Current Science. 70, 7; 1996, April 10; 629-635.

The tools of geographic information system (GIS) which can be used in a variaty of ways to addressed. With the availability of high spacial resolution data of IRS-1C, many new ways of looking at urban utilities and environment have been illustrated. The new GIS models which can be adopted on an operational basis by developing and linking data bases in spacial and non-spacial from dowm to cadastral level have been explored. Day to day problems of the urban dwellings, ie traffic and transportation, greenery, solid waste disposal, pollutions, location of new layout for urban growth, road alignments, etc. have been given a new look under the GIS environment with posibilities arising formthe high resolution colour images of IRS-1C.

--------,------, ------, ------, **LOADING SYSTEM, STRUCTURAL TESTING.**

136) SAMUAL . Automated static loading system for IRS-1C space craft structural testing. Journal of Space craft technology. 3, 2; 1993, February; 56-60.

A channel individually controlled electro hydraulic servo loading system was developed, tested and employed for INSAT-II static load tests. The experience

gained there in has been made use to develop a simplified and more reliable multichannel automated static loading system for space craft structure testing. The paper gives details of the loading system which was successfully used for static testing of IRS-1C structural model.

-------, ------, ------, ------, **STAR SENSOR.**

137) THOMAS (P). Star sensor for Indian remote sensing satellite (IRS-1C). Journal of Space Craft Technology. 4, 2; 1994, February; 36-42.

A microprocessor - based star sensor system using an area array charge couple device (CCD) as detector has been developed for the attitude determination of Indian remote sensing satellites IRS-1C and 1D. A pair of sensors with field of view (FOV) of $8^0$ x $6^0$, maounted in skewed configuration in the 3-axis steabilised satellite platform, capable of detecting stars up to 5.0 visual magitude (MV) can give an altitud determination accuracy of better than 0.01 degree.

----------, --------, ----, ------, **TTC NET WORK.**

138) VENKITACHARY(KV). TTC net work and space craft control centre for IRS -1C. Current Science. 70, 7; 1996,April 10; 224-223.

ISRO Telemetry tracking and command network (ISTRAC) performs spacecraft control operations and TTC functions for IRS-1C mission. Telemetry tracking and command network for IRS-1C comprises of ISTRAC stations and external agency ground stations providing tracking support for the mission. The space craft control centre (SCC) at Bangalore uses mission computer and misson specific software for IRS-1C mission. Deals with the ground segments support provided for IRS-1C mission consistory of TTC ground stations, SCC, mission software and communication links during the launch and early orbit phase of support along with other on going mission .

-------, -----, -------, -------, **X-BAND DATA TRANSMITTER.**

139) PICHYYA (B). X band data transmitter for space remote sensing mission. IETE technical review. 11, 2-3; 1994, February-March; 129-35.

Decribed an X-band transmitter designed and developed for Indian Remote sensing satellite (IRS)for transmitting the imagery data obtained by the on-board linear imaging self scanning camera. The transmitters flow on-board IRS 1A and 1B are performing to its expectations in transmitting valuable data of the imageries of the Indian region. The design criterian

along with the description of various stages of the tranmitter have been discussed in this paper.

------, ------, ------, ------, -----, ------, **SOLID.**

140) RAO(VS) X-band solid state power amplifier for space use. Engineering education. 27, 3, 1995; 27-35.

Describes the use of 12 watts, X-band solid state power amplifier that is developed, fabricated qualified and now being used on board IRS-P2 in place of travelling wave tube amplifier for X-band down link amplification. Design concepts and performance parameters in performance between the travellig wave tube amplifier and advanced solid state amplifier are descussed.

-------,------, -------, -------, **DATA, GAS WELL BLOW DUT, OBSERVATIONS.**

141) BADRINATH(KVS) On shore gas well blow out and its impact observed using satellite data. Current Science. 69, 7; 1995, Dec; 604-07.

The blow out of ONGC onshore gas well 19 located at Pasarlapudi in Andhrapradesh occured on January 8, 1995, monitored by the Indian remote sensing satellite IRS-P2. The space borne sensor due to synoptic and repetitive coverage provide data over large region and have the adapt of providing data over inaccesible regions optical data from IRS-P2 and LAND SAT have been analysed with a view to study the impacts due to blow out, and ground based measurements have collected with the satellite based obserations. It includes, analysis vegitation vigour estimating the temperature of gas well

etc. The analysis of satellite data suggested localised effects due to the oil well blow out. The temperature values estimated are in conformity with ONGC ground observation. The noise pollution level are high and damage of cocunut plantation in down wind direction were observed within 200m zone. The net observation is that an area of 200m radius in the zone of influence of blow out. Altogether the satellite technology could facilitate synoptic observation of such episode events.

---------, --------, -----, -------, **LAUNCHING.**

142) INDIA'S FIRST polar satellite IRS-P2 launched by PLSV- D2.Current science. 67, 8; 1994, 25 october; 565-70.

Editorial commentary on the second developmental flight of PSLV-D2 which successfully orbitted IRS-P2 satellite into a precise polar orbit. The primary objective of PSLV-D2 is to put IRS P2 in the polar sun synchronous orbit and that of IRS-P2 is to use this oppertunity to provide images using linear imaging self scanner, LISS II etc. The major work centre of PSLV-D2 IS VSSE at TVM and SHAR of Sriharikota. The PSLV-D2 has got gigantic facilities than ASLV. The cost of PSLV project is 414.96 crors.

-------, -------, **LAUNCH VEHICLE.**

143) GUPTA(SC). Growth of capabilities of India's launch vehicle. Current Science. 68, 7; 1995, April 10; 687-691.

In 1994 India launched successful mission of ASLV-D4/SROSS C2 and PSLV 2/IRS-P2. This has been achieved due to the world class performance of the vehicle subsytem. Print out ISRO's improvment in the designing of launch vehicle and the methodologies used for various mission of ASLV-D4/PSLV are explained. Using the mission performances of the landmark importants in the orbital injection accuracy are examined. Injection accuracy of PSLV-D2 imparted to IRS-P2 is compared with that of IRS-1-Aand IRS-1B claims the PSLV-D-2programme having a world accuracy.

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144) GUPTA(SC). On the launch vehicle scenario for India. Journal of space craft technology. 5, 3; 1995, July; 1-9.

The launch vehicle scenario in India is mainly due to over come the present status of launch vehicle technology as India successfully tested ASLV in 1992, 1994 and RSLV in 1994 which indicates the maturity in this field. The GSLV mission will take the country close to the operational capability for the geo-stationary orbit mission for meteorology, telecommunication and broad casting. The potential evolutionary improvements in the performance of the PSLV and GSLV, concurrently with their productionisation are indentified. In order to compare various advanced launch vehicle concepts, a brife resume of the recently published studies carried out in some countries is presented.

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145) SRINIVASTA(SK). State estimation using an effciant square root filter during the powered flight of a launch vehicle. Journal of aeronautic society of India. 39, 4; 1987, April; 8-24.

An efficient approach for computation of the state during the power flight of a launch vehicle form rader data is presented. It employs an advanced square root filter along with a polynomial state

prediction model. As an illustration the position and velocity of a typical multi stage launch vehicle are computed with high accuracy from a set of observation.

**-----, ------, ------, ASLV.**

146) REDDY (MB) and DEV (MSR). Augmanted satellite launch vehicle (ASLV). Current Science. 66, 6; 1994, March 25; 408-416.

The launching of the ASLV-D3 on 20$^{th}$ May 1992 proceeded by a flawless count down resulting in the successful injection of SROSS in to LEO is a major mile stone for the launch vehicle development programme. ASLV project was designed as a low cost launch vehicle for highly complex technologies which is incorporated in the polar satellite launch vehicle and geostataionary launch vehicle. The development of complex technologies such as cented nozzle, bulbous metallic heat shield design and fabrication of strapon motors, acheiving and demonstrating the differential thrust required between strap-on motors and closed loop guidance system were primary objectives. ASLV is a five stage solid propellant vehicle weighing 40 tonnes and a length of 23.8m. The total flight from of the mission was about 500s.

**------, ------, ------, ASLV-D4, MISSION.**

147) MANOHARAN(V) and MOORTHY (Narayana D). ASLV-D4/SROSS C2 Mission. Current surface. 66, 12;1994, June 25; 897-900p.

The fourth developmental flight of ASLV-D4 carried a stretch Rohini satellite in the orbit on 4th

May 1994. With the success of last consecutive flights, many technologies required for launcher have been demonstrated by ASLV programme. Hilights the mission objectives of ASLV. Unlike ASLV-D3, there is a spin up system. A number of significant changes were carried out in ASLV-D4 mission, like tools for minimising electronic package. The flight sequence is also been described here. The various technological inputs provided by ASLV mission are summarised. Apart from various centres of ISRO, many Indian Industries and Research and developmental labs and scientific institutes have taken part in the design reviews and analysis.

------, ------, ------, **CRYOGENIC TECHNOLOGY.**

148) NAMBOODIRY(EVS) and BHATT(MS). Cryogenic technology in satellite launch vehicles. Indian Journal of Cryogenic. 9, 2; 1984, February; 102-9.

Discusses the developments and deals with the comparison of performances of solid, stearable liquid and cryogenic propellant combinations. The growth and improvments of engines for space shuttle in various countries are highlighted here. Further, the impact of high performance cryogenic upper stages for a typical launch vehicle, on its take off weight and size vis-a-vis the payload capability as compared to storable type is discussed.

Aspects pertaining to materials, fabrication techniques, production and storage requirements are also briefly covered.

-------, ------, ------, **PSLV.**

149) AGHARWAL(Yogi). Poised for a leap: ISRO the emerging international player. Frontiline. 16, 3; 1992, July 2; 52-54.

With the launching of a rocket capable of putting an one tonne satellite in orbit, is on the verge of a quantam leap. The PSLV 280 tonne, four stage vehicle will carry the remote sensing satellite to the orbit. The Indian industryu has played a great role along with ISRO scientists dot build the PSLV. The programme of satellite launch vehicle launched and be launched are described. ISRO is in contract with Russian space agency GlavKosmos for making GSLV.

--------, --------, --------, **PSLV.**

150) SUBRAHMANIAM(MS). PSLV: A great leap forward M 'n' M Magazine. 2, 9; 1994, December; 6-8.

Describes the maturity obtained with the launch of PSLV for ISRO this type of technologyis essential for the defence purposes of the country. PSLV was carring a remote sensing satellite and it injected with better accuracy than expected. The propulsion, electronic and other systems was very carefully done. The main role of PSLV is to place Indian Remote sensing satellites in to a 900 km polar orbit more successful PSLV launches will enhance India's capability in military reconnaissance. The PSLV vehicle gives us the capability to launch more sophisticated recnnaissance satellites.

-------, -------, ------, ------, **MISSION.**

151) RAO(UR). PSLV-D1 mission. Current Science. 65, 7; 1993, October 10; 522-525.

The first developmental flight of the indigenously developed 44m tall, polar satellite launch vehicle (PSLV), carried out form SHAR centre Sriharikotta 20'th Sep 1993 is a major mile stone in the countries self reliance in the highly complex launch vehicle technology. A small description of PSLV the mission flight etc are being described. The flight has demonstrated the performance of practically all the subsystems of PSLV and has validated the design aspects of the vehicle as well as the infrastructure needed for such an elaborated mission, eventhaugh the space craft could not be orbited due to unexpected disturbance to the vehicle around the separation of second stage from the 3rd stage. Bring out the priliminary quick look results of the mission.

------,------, ------, ------, **ROCKET PROPELLENT.**

152) MAMA(Hormoz P). India's Rocket propellent developments. Space flights. 37, 1; 1995, January; 32-35.

On the 15th October 1994, the first successful launch of polar satellite launch vehicle (PSLV) from Sriharikota launch vehicle station took place. This shows India's propellent development efforts which has been done for many years met the target Behind this success lies a longstanding and active programme of Indian rocket production. Discribes the various steps of propellant production which have been used to launch PSLV are discussed.

-------, -----, -----, **PSLV-D3.**

153) KOUL (Ravi). Building on PSLV-D3 launch success

Chanakya Aerospace Defence and Maritime Review. 22, 4; 1996, April; 16-20.

With the successful launch of the PSLV-D3 and India's entry into global launch facilities club, in which others have experienced many failure ISRO must look forward to meet entire range of vital requirments when it has the capability to meet the requairments it self and enter a lucrative export market. While the time for pathing ourselves on the back has passed, we now have to take on these responsibilities that come from growing out of child hood and reaching the age of manhood. It is obvious that in addition to a launch programme for satellite of other countries , ISRO must also concentrate on loading the Indian ocean countries in satellite production for the benefit of the region in both civic and military areas.

------,------,-----, **TRAJECTORIES, AERO DYNAMIC, FORCES.**

154) RAM KUMAR(Satish).Concentrated aerodynamic loads at pre-determined elements of Rocket/ launch vehicle for aeroelastic analysis. 48, 1; 1996, February; 91-95.

A flexible trajectory analysis is essential for the design of slender, multi stage rockets. In the study aerodynamic forces acting on the vehicle plays a major role. An usual approach to the aeroelastic analysis of rocket will be to replace the aerodynamic and structural charecterestics of the lumped parameters located at pre-determined control points. The aerodynamic

forces acting along the body of the rocket /launch vehicles are distrubutive in nature. If this distribution function is replaced by a system point parameters at the control points, then the flexibility equation can be solved easily. A method was evolved and a code was developed using least square techniques to estimate the concentrated forces acting on the control points with total force, moment as constraints and optimally matching the shear force digram. The application of these methodes is demonstrated by an example.

**-------,------, OPTICAL TRANSMISSION, MONITORING DATA.**

155) GARG(VK). Optical transmission monitoring of satellite data signals. IETE Technical Review.13, 1, 1996,January-February; 21-3.

Each new innovation in satellite communication has been either to improve fiedility, to increase data rate or to increase the transmission distance between relay stations. These prograssive trends led to developmental activities in optical and satellite communication. The bit-error-rate (BER) estimate of optical transmission is suggested. Suggest that the optical phase division multi plexed scheme has great potential for mult carrier transmission.

**--------, ------, ORBIT, OPERATION.**

156) BHATNAGAR(B). Rotational motion of a satellite in an elliptical orbit under the influence of third body torque. Bulletin Astornomical Society India. 22, 4; 1994, April; 439-49.

The rotational motion of a satellite in an elliptical orbit under the influence of the third body torque is being studied. It deals with the non resonance cace and the resonance case and the chaotic nature of the given dynamical system. By using Melni Kov's method shows the three equations of motion are nonintegrable. Taking the third-body perturbation of the order of eccentiacity and usig BKM method it is observed that the amplitude of the oscillation remains constant up to seconds order of approximation. The main and parametic reasonces have been shown to exist.

-------, --------, ------, **POSITIONING.**

157) PATKI (AV). On positioning of satellite. Science Reporter. 21, 9; 1984, September; 437-440.

The movement of man made spacecraft and artificial satellite can be explained by simple laws of physics describes the path flights of satellte. Which are divided into two phases, the controlled flight paths and uncontrolled flight paths. These two laws controlls the space craft motion. The high speed digital computers and the proper engineering judgment make the motion predictable. Restrict its attention to the practical orbit of man made satellites. There are two prameters of orbital classification, and one is used for stationary orbit for communication satellite like INSAT, and the other is used for polar orbits used for the purpose of photography and remote sensing like in IRS.

------, ------, ------, -------, **GLOBAL.**

158) BANERJEE(P) and BOSE(Anindya). Evaluation of GPS PDOR from elevation and azimuth of satellites. Indian Journal of Radio Space Physics. 25, 6; 1996, June; 182-90.

To provide continious globhal positioning capability global positioning system (GPS) has been established to have 12-h orbit inclined at $55^0$ to equatorial plane. Now the constellation of GPS is full. Thus for elevation angle above $10^0$ these will often be more than seven satellites available for use. A formulation to evaluate PDOP (dilution of precision) only from the knowldge of elevation and azimuth of GPS satellite have been developed. A programme has been

developed to compute PDOP with the above formulation. The PDOP thus computed matches well the data available in GPS reciever. This formulation will be useful to plan many common view GPS experiments.

--------, -----, -----, **PARAMETERS.**

159) PATKI (V). On satellite orbital parameters. Physics Education. 11, 2; 1994, February; 189-93.

Spacecraft orbital primarily determined by the simple laws of physics. Given brief description of the orbital parameters, needed to completely specify on orbit. The practical or the engeneering relevence of these are discussed. Analogy with the relevent. Based on these parameters, the orbit classfication is briefly covered. Finally a note on the application is added to give better insight into their implications.

---------, --------, **PAYLOAD, THERMO VACCUM SYSTEM.**

160) NARASIMHAN(N). Experiences of using cryo pumps and turbo molicular pumps for thermovaccume systems to test satellite payloads. Bulletin of Indian Vaccume Society. 26, 1; June; 21-7.

The thermo vaccume test for satellite payloads is mandating test to bring out the design deficiancy, component defect as well as workmanship defects. These tests are typically carried out on 24hr basis normally long duration tests varying form 70 to 168hr and include multithermal cycling from $-40^0$ to $60^0$ in high vaccume and demand of oil free clean vaccum as the satellite payloads are the electro optical high resolution comera. Describes the experience gained in selection and using cryopumps and turbomoleculer pumps.

-------,-------,**REMOTE SENSING.**

161) COSPAR SCIENTIFIC ASSEMBLY (ON) REMOTE SENSING OF EARTH'S RESOURSES ( 30TH: 1994: HUMBERG). Space research in India: Report. 104-120.

The Indian remote sensing programme has made significant achievement over the past two decades. With the successful launch of indigenous state of art IRS-1A and 1B and the avilability of full fledged ground segment with necceary infrastructure to recive, process, disseminate and analysis the data for various applications project under NRMS are regarding the use of agriculture, bioresource, environment etc. For this purpose various goverment offices have been established under Indian Government. In this report, the technique which have been used for then purposes are discussed. Also the varuios departments entaged in carrying out these purpose are described.

--------, -------, --------.

162) DEEKSHATULU(BL) and JOSEPH(George). Science of remote sensing. Current Science. 61, 3-4; 1991, August; 129-135.

Remote sensing is the science of deriving information about an object from measure ments made at a distace from the object, and with out the sensor actually coming into contact with it. The observation is made on the reflected / scattered or self emitted electro magnetic energy form the earth in different wavelenght bands. The reflectance/temporal,etc, conditions provides

forms the basis for data interpretation. Describes the basic principles involved in remote sensing. The advancement of remote sensing requires enhancement in the copabilities of sensors and computer processing.

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163) NAVALGUND (RR) and KASTURANGAN(K). Indian remote sensing programme: Overview. Proceeding of Indian science Academy. 6, 4; 1983, December;325-32.

Various considerations that have gone into the definition of different subsystems of each of the pricipal elements of the Indian remote sensing satellite programme are discussed here. Different elements of IRS utilization programme and their role in the evolution of a national natural remote sensing management are also out lined.

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164) RAJAN(YS) and NINAN(J). International scene in remote sensing. Proceedings of Indian Academy of Science. 6, 4; 1983, 378-86.

A brief survey of the status of remote sensing or earth observation, from space as applied to earth bound system under execution and under planning are given. Utilisation of the remote sensing technology by developed and developing countries is reviewed pointing out current problems and future potentials.

--------, -------, --------.

165) RAO(UR). Remote sensing for National Development. Current Science. 61, 3-4; 1991, August 25; 121-128.

The remarkable developments in space

technology and its application during the last three decades have firstly established its immense potential for tranforming the life style of the human society. Backed up by adequate ground truths and aerial photo graphy, space remote sensing has fully established its potential to provide vital inputs to the monitoring of our basic natural resources such as agriculture, forestry, water resources, soil classification, ocean resource monitoring
and drought management. Remote sensing is a unique field which has brought scientists of various disciplines together in a demostration of how science can directly contribute in the national development thruogh judicial planning as exemplified by several national level study projects. With the advent of advanced techniques like digital terrain modelling, and geographical information system and the availability of advanced sensors/ satellite as well as methodologies optimum utilisation of remote sensing technology for national development is well in the advance for the development of a country.

------, ------, ------, **APPLICATION, AGRICULTURE.**

166) SANWALD(EF). Interpretation of aerial photography for agriculture application purposes. Photonirvachak. 11, 2; 1983, February; 63-66p.

The usefulness of remotely sensed data for agricultural purposes being undisputed, comparatively few examples have been made to ensure their practical applications with special reference to aerial

photography, the existing gap between pedological/ hydrological and photgrammetical evolutions is yet to be used.

------, -----, -----, -------, ------, **SUGER CROP.**

167) PARRY (John). Monitor Suger beet crop. Telemetics India. 9, 11; 1996, August; 52-3.

Data from remote sensing satellite can play a crucial role in predicting suger-field, a crop that is central to the Indian agricultural economy. With airborne remote sensing has been found to be more accurate and convenient than ground sampling, it is unable to compete with the potential performance of satellite system which have the spatial resolution to identify field.

-----,----, -----, -----,------, **WHEAT, PANJAB.**

168) MEDHAVY (TT). Development of a wheat yield model for punjab using remotely sensed data and historical yield trends. J. of the Indian SOC of remote sensing. 23, 1; 1995; 23-30.

Spectral yield model from the satellite data were updated by incoperating the latest set on district wise NDVI and wheat yield for Panjab. In orderto improve the modle, historical yield for the years was used to derive a linear regression relation for each district.

--------,------,---------,-------, **DROUTHT ASSESSING, SURFICIAL DATA.**

169) GHOSH (IK) and TRITPATHY (GG). Assessing drought by using satellite ad surficial data. In proceedings of Indian Scienc Congress Association. 80,4; 1993, September 3; 301.

Drought in arid and semi arid region has been analysed based on digital analysis of satellite data and a large set of surficial (meteorological) data. In arid region principal component analysis (pca) and directional filtered (DF) image analysis have been carried out to assess the drought conditions, where as in semiarid region, normalised differnce vegitation on index (NDVI) and Albedo Index have been used to assess the drought. The meteorological drought indicators are however correlated with the satellite data indicators and together assess the drought conditions.

------, ----, -----, -----, **ENGINEERING.**

170) DEEKHATULU(JK). Engineering and technological issues remote sensing in proceedings of Indian National Acadamy. 1993, 59, 3; 226-250p.

Briefly traces the development of remote sensing in the world in general and Indian in particular. The significant application of remote sensing in engeneering and other disciplines are discussed in detail. The developments in Indian industry for the production of remote sensing sensor and interpretation and analysis are described. The present activities in

India as well as the future trends in the remote sensing systems or mission techniques are also described.

------, -----, -----, ------, **ENVIRONMENT.**

171) KHANNA(P) and DONDAWAR (VK). Application of Remote sensing Techniques for enviromental Impact. Current Science. 61, 3-4; 1991, 25 August; 253-6.

Environmental Impact Assessment is potentially one of the most valuable interdisiplinary, objective decision making tools with respect to alternate routes for development. Process technologies and project sites. The major methodological limitations of EIA relates to resourse requirements for data collection. While elaborating the role of EIA in developmental planning discusses the role that remote sensing techniques could play in data collection for vegetation and land use mapping with the help of a case study.

-----, ----, -----, ------, **FORESTRY, KHAND RAJAJI PARK.**

172) DAS (KK). Forest cover monitoring using remote sensing and GIS: Casestudy in Dhaulkhand Range of Rajaji National Park, UHER prodesh. Photonirvachak. 24, 1; 1996, January; 10-15.

Rajaji National Park in U.P is a protected area where large number of nomad population lives within the park area. There dependence on the forest for cattle rearing and firewood has caused degrredation of the forests. Proxinity to settlements outside the park further adds to the problems. In the present study, forest cover and river bed changes have been attempted by

using tanporal aerospace data of the year 1960 and 1963. Subsequently PAMAP GIS package has been used for the change detection analysis. The study indicates the use of Remote sensing for land cover.

------, -----, ------, ------, **GEO RESOURCES, INEAMENTS.**

173) REDDY(Venket). Application of remote sensing tecnique for evoluating georesources with special reference to the lineamants. Indian Remote Sensing Research Bulletin. 1, 1; 1992, January; 18-21.

Space borne and airborne remote sensing had succcessfully proved to be on importent tool in providing vital information about resources available on the earth. Geologic origin lineaments such as folds faults, fractures, joints, dyker, ridges etc are great imoprtance in exploring the geology of the area mineralisation and subsurface conditions. All linear features which appear on the iages are not truegiologic origin lineaments. It is necessary to distinguesh between true geologic origin lineaments and other linear featurs. This article highlights the techniques for understanding about these features with the help of remote sensing data.

------, -----, -----, ------, **GROUND WATER STUDY, DARJILING.**

174) JANA (MM) Ground water study in the piedmont zone of mechi Mahananda interfluva in Darjiling distric, West Bengal using Remote Sensing Techniques. Photonirvachak. 24, 1; 1996, January; 48-52.

Nearly 25 pecent of the total volume of fresh water of the earth is stored as underground, of which only 11 percent lies at the depth above 750m and

the rest lying deep below making it a little difficult to draw for our emmediate use. Using Remote sensed data it can be possible to understand the ground water availability and can take suitable measure to use the ground water. Also from this data, it is understand that the drainage system of the area has a close rdation ship with lighology and land from. It is concluded from the remote sensing data that the area has good prospects for ground water exploration to fulfill the demand of water for irrigation and domestic purposes.

-----, -----, ------, -------, **IRRIGATION, INFRARED.**

175) KADAM (UR) and MAGAR (SS). Irrigation scheduling with thermal infrared remote sensing imputes. Journal of Maharashtra Agricultural Univercity.19, 2; 1994, July-December; 273-6.

Irrigation Scheduling with thermal imfrared is modern technique as compared to other methods which is developed from the conopy temperature. In India, littel work has been carried out on various corps like tomato, wheat at Indian Agricultural Research Institute, New Delhi. Data show that the stress degree day provides a valid indicator of crop water stress. These appears to be promised in the use of infrared thermometry to schedule irrigation and it could easily replace other more labour and time intensive mithods plus cover large area quickly and reliably.

-----,------,-------,------, **LAND SCAPE, ECOLOGICAL**

**ANALYSIS, MANDHAVA NATIONAL PARK, MADHYAPRADESH.**

176) RAVAN(SA) and ROY(PS). Land scape ecological analysis of distrubance gradient using geographic information system in the Madhava National Park, Madhya Pradesh. Current Science. 68, 3; 1995, February(1-15); 309-15.

The present study is aimed at analysing the imact of a disturbance on landscape structure using satellite remote sensing and geographic information system (GIS).The land sat TM data have been used to indetify vegetation types. The patch charecterestics of the vegitation types, viz, size, shape, porosity and patch density have been studied. Physical and man made features hav devided the national park into three zones, viz north, central and south. These zones are also utilized as management zones by the forest department. The study indicates that the central zone is distinctly different from south and north zones.

--------,-------, -----, ------, **LAND USE, KALE RIVER BASIN, SOUTH INDIA.**

177) HEGDE (R). Changing land use /land cover pattern in the kali river basin in western ghats of south India. Current Science. 66, 2; 1994, January; 128-37.

Multitude satellite datahas been used to qualify the land use /land cover changes in the kali river Basin for the period 1975-88. The analysis of spatial data showed that there have been significant changes in the land use / land cover of the region owing to execution of the kali Hydel project. An attempt has also been cover that would be indueed in the area to be

submerged due to the dams.

-------, ------, --------, --------, **MARINE ENVIRONMENT.**

178) MURLIKRISHANA (IV). Optimal remote sensing of marine environment. NRSA technical report. 26, 0957; 1984,

For under standing the marine environment, the comprehensive data base in required which could be acquired from satellite remote sensor. The planing of remote sensing measurments from space in conjection with the other ground based components is discribed. On the similar grounds extensive observations of sea surface temperature for validation of ther mal informed measurements from space are sugeested. Also one satellite data carresponds to surface manifestation and is appropriate to identify the role of to data in the context of satellite data availability combination of the insine and satellite data leads to assesment of the three diamensional configuration of marine environment.

-------,------, ---------, --------, **METEOROLOTY, SNOWMELT RUN OFF, FORCASTING.**

179) RAMAMOORTHY (AS). Forcasting snow melt run off using satellite imagineries. NRSA Technical Report. 28, 9; 1984; 99-105.

Satellite remote sensing technology has enable monitoring snow cover area of the Himalayas which was not hitherto possible be conventional methods. Using snowcover area obtained from NOAA meteorological satellite imagiries as the parameter. The snow melt run off of stuley into Bihak reserviour since 1980 was forcast and the forcast quantities have been very close

to the actual observe flows within 10 percent.

--------, -------, -------, ------, **PETROLIUM EXPLORATION.**

180) AGHARWAL (RP) and MISRA (VN). Application of remote sensing in petroleum exploration: Case studies from north eastern region of India. Indian Journal of Petroleum and Geology. 3, 2; 1994; 45-60.

Satellite remote sensing techniques have been become on established tool of petroleum exploration. Oil an natural gas corporation (ONGC) since its inceptionis utilising remote sinsing as one of the basic input for petroleum exploration. A few stractures recommended for remote sensing techniques were refined more and new methodologies were developed and the results were integrated with the available surface and subsurface geological and geophysied information. The study focuses on the exploration of hydro carbons. The methods and techniques have two primary advantages, ie their cost effectivness and time efficent which are important in exploration venture. This study include visual interpretation and digital image processing .

------, --------, -------, --------, **RESOURSE MANAGEMENT.**

181) RADHA KRISHNAN. Infra structure in India for analysis of remotly sensed data. Current Science. 61, 3-4; 1991, August 25; 266-270.

The National Natural resourse management system (NNRMS) is conceptualised as an integrated resource management system to aid to ward optimum management of the natural resourse. Towards realising the

goals of National Natural Resources management system, conceptualisation as an integrated resources management system the first step has been to establish indigeniously spate and ground segments. While the space segments consists of operationalistion of the IRS series of satellite, appropriate data reception disseminasation and analysis facilities / infrasturcture from the ground segments. This paper lights the achiev ment made in the estabilishment of data analysis facility in the country.

------,--------, --------, -------, **SEDIMENT DISTRIBUTION, TUNGABHADRA.**

182) CHOUBEY (VK). Assessement of sediment distribution pattern in the Tungabhadra reserivior using satellite imagery. Journal of Indian Society Remote Sensing. 22, 2; 1994, February;103-111.

Inorder to undestand the dynamic aspects of suspended sidiments in and inland water body, Tungabhadra reservior on the Thungabhadra river in the Krishna water basin was studied. The study has been carried out using land sat MASS and IRS -1A LISS images. Visual interpretation techniques have been used to obtain information on the location and extent of sediment istribution patterm in the reservior. An attempt has also been made to prepare area capacity curve for the reservior semi quantitative assessment of seiment deposits between reservior levels were made considering water spread area from the satellite images and sedimentation survey report of Karnataka Engineering

station.

--------, ------, ------, --------, **TERRESTRIAL ENVIRONMENT.**

183) SINHA(NPK) and SINGH(R). Remote sensing of terrestrial environment. Geological review India. 49, 2; 1987, Feruary; 21-37.

The theoretical and technical basis of remote sensing in reviewed. The potential of remote sensing techniques fo geographical research are discussed. The most geographically significant aspects of remote sensing invlove the perception and recording of terestrial phenomena by equipment carie in air craft or satellites and the subsequent use of the data so obtained. Terrestrial remote sensing depends upon the fact that the surface features and certain phenomena are recogniseable by destinct signature which result from their differential response to electromagnetic energy. Different remote sensing using systems are designed to record energy within various bands of the electromagnatic spectrum.

-------, ------, ------, -------, **WARLAND, SOILS, DEORIA.**

184) RANDE(LM) and IYER(HS). Warland loils in part of Deoria district using remote sensing techniques. Journal of National Remote Sensing Technique. 27, 0969; 1984; 11-13.

A case study was taken up in approximately 700 sq km area of the Gondak river system of part of Deoria district in east Uttar Pradesh to charecterise the warland soil. Remote sensing technique using multidata land sat and imagery followed by aerial photo

interpretation was helpful in delineating seasonal an permanent wterlogged aras. A close relationship was found between physcographic Units and water logged area.

-------, -------, -------, -----, **WASTELAND.**

185) SUGUMARAN(R). Potential of satellite data in delineation of wastelands and correlation with ground information. Journal of Indian Society of Remote Sensing. 22, 2; 1994, February; 113-8.

Attempt has been made to delineate the wastelands at microlevel in Natartaluk IRS LISS II digital data of 1991 has beenused for the study which was analysed on VAK II/780 image procesing system. The digital data was classified following superrised classification algorithim. The three types of waste lands namely water logged, pasture/grasing and salt effected lands could be identified and mapped. The area staistics for thediferent waste land categories present inthe taluka were generate chamical analysis was also carried out for soils collected fromdeferent categories of wastelands to understand the exact netime of soil of each catagory.

------, ------, ------, **COMMERCIALISATION.**

186) RAO (Mukund) and JAYARAMAN(V). Commercialisation of remote sensing: Issues and prespective. Current Science. 70, 7; 1996, April; 642-647p.

Now the Remote sensing through satellite can provide data on the earth and its natural resourses for large area coverge for getting timely information.

Remote sessing has reached a level of operationalisation in India and is baking used for a variety of appplication for verious managements with the operational services from IRS satellites user agencies Govt. and a few private agencies are using RS data for their routine work. The need now is to sustain this for the future one method now set for sustaining the remote sensing technology encouraging commmercial use of space based RS market segments encouraging this in consenance with the overall economic liberalisation. The intent must be to catalyse industry to participate in system and technology integration for promoting information industry based on RS data. In this article we discuss the -consaction that RS technology has seen in the from an experimental programme, where the stress was on promotion of RS through an operational programme. The strategics that will have to be adopted are encompassing technology, applications, manpower development, infrastructure development, marketing etc have been discussed in this article.

--------, -------, -------, **COST EFECTIVENESS.**

187) RADHA KRISHNAN(K). Economic of Remote sensing. Current Scince. 61, 3-4; 1991, August 25; 272-276.

Remote sensing is now being used as and altermative technology for the inventory, survey, planning and management of natural resourse and monitoring of envionmental changes. In this paper, an attempt is made to identify the cost components and

benefits of using remote sensing. It was obsered that cost benifit analysis is more diffecult that cost efectiveness analysis. Case studies, demonstrating the cost effectiveness of using remote sensing along with the lines is provided to determine the most remunirative alternative for implementing a remote sensing project for solving natural resources management problems. The emphasis here is to help the user in making suitable judgements to ensure returns from investments and enable him to utilise the limited financial resources for diriving the maximum benefits.

------,-----,-----, **DIGITAL IMAGE PROCESSING, OIL EXPLORATION.**

188) MITRA (DS). Digital image processing in remote sensing principels and application to oil exploration. ONGC Bulletin. 24, 1; 1987, March; 13-30.

The use of digital sensor in earth resources application is well established. The signals sent to the ground from the satellite scanners are converted to digital numbers prior to tranmission. If such sensor are converte to serve a useful role in the surveying and management of earth's resources, efficient methods for correcting and extracting information from the sensor out must developed. In this paper techniques for implementing image correction enhance ment and information extraction are described and results of some of the digital image processing techniques are presented.

-------,-------,-------, **ROHINI REMOTE SENSING, SMART**

**SENSORS.**

189) ALXX(TK) and KURIAN (KK). Eye of the Rohini. Science Today. 18, 2; 1984, February; 52-55.

"Rohini"-D2 the smallest remote sensing satellite has a very sophisticated camera called the smart sensor. It has inbuilt intellegence for on-board decision making. The advent of these intellegent camaras comes in the wake of advances in solid state technology. The smart sensor has lenses which can take pictures of four ground featurs namely, water vegitation bare land and cloud snow. Single band imagery logether with feature picture has a wide range application in the field of remote sensing. Rohini-D2 sover as a platfrom to test many new technologies in a single flight. The smart sensor techniques successful tested in this flight and all the missing goals of the coming system have been met. The features of the sesor camer of Rohini-D2 have been hiliglighted .

------, -------, **ROHINI, TERESTRIAL GRB.**

190) KASTURIRANGAN(K). Cosmic gamma bursts. Current Science. 69, 9; 1995, December; 732-738.

A non terrostrial phenomena occuring in space can be used to maonitor any violation of nuclear test ban with the help of suitable satellite. It was first detected by U.S satellite US-Vela. In this article an attempt has been made to review GRB'S and from an observational level study on the launch of compton gamma ray observatory by Indian space Scientists. The motivation for the Indian GRB experinents flown on the

streteched on the Rohini satellite Series (SROSS -C1 and SROSS C2) and their observations are also presented here. Discusses the technique of interplanetory technique of detectors currently monitoring the GRB's the GRB experiment on SROSS C2 will underge earth occulation, complete sky coverage at all time and complement data obtained by CGRO and GRANAT in near earth space.

------, -----, ------, **RS-D2, SMART SENSOR.**

191) RAMANI(S). Methodology of feature classification by the smart sensor on board the Rohini RS-D2 satellite. Current Science. 53, 6; 1984, March 20; 287-292.

A large amount of remotely sensed data from earth observation satellite are generally collected in any space mission. On board features classification has been attempted for the first time in the Rohini (RS-D2) satellite using the two band optical smart sonsor. The on board feature identification ciruit takes the out puts from the two cameras together with a given threshold and two slopes and generates a two bit lode representing one of the four broad terrain classes; Water, base land, vegitation and land/snow.

-------, ------, **SROSS-C2.**

192) MARAR (TMK). First Result from the Gamma Ray burst experiment on SROSS-C2 satellite. Journal of Space Craft Technology.5, 1; 1995, January; 75-79.

An experiment to moitor celestial gamma ray bursts (GRB) in the energy domain 20kev-3 Mev was launched on board the SROSS-C2 satellite on 4 May 1994.

The payload is designed to record, with good resolution time histories and energy spectra of GRB'S. It has a fine time resolution of 2ms and is therefore, capable of recording rapid intensity narrations in strong bursts. Highlights of the instrumentation and some of the candidate GRB events recorded by the payload have been discussed.

-------,------,------, **APPLICATION, AERONOMY,**

**EXPERIMENT.**

193) GARG(SC). Aeronomy experiment on SROSS-C2. Journal of Space Craft Technology. 5, 3; 1995, July;10-22.

Discusses the effect electron in introducing errors in transionospheric radio signals, essential for satellite communication, geodery, navigation etc. SROSS-C2 the fourth space craft of the streched Rohini satellite series which is spin stabilised satellite carrying two scientific pay loads, GRB and retarding potential analyser. The RPA payload can investigate the charecteristics and energetics of the equitorial and low latitude ionosphere and thermosphere. The design of the RPA payload in an improved version of a similer payload flown abroad the SROSS-C2 satellite on May 20, 1990. The design in orbit operation and performance of the RPA payload on the SROSS-C2 are describe.

--------, --------, **SROSS-C2, GRB DETECTOR.**

194) MANOHAR(SB). Effects of dead layer on the detection efficiency of SROSS-C2 GRB detector. Journal of

Space Craft Technology. 6, 1; 1996, January; 72-78.

A scintillation detector was flown on-board the SROSS -C2 satellite on May 4, 1994. With the objective of monitoring highly energetic and mysterious celestial phenomena known as Gamma Ray bursts. Detection efficiency measurements on the sodium doped iodide scintillation as a function of gamma ray energy in the range 60 kev to 840 kev has shown the existance of a deactivated (dead) layer on the scintillation, the effect of which is to reduce the detection efficiency of the detector to low energy gama rays. The dead estimates and its implication on the gamma rays are presented.

-------, ------, --------, ------, **DETECTOR, EFFECT.**

195) PADMINI(VN) and PRASAD(NL). Effect of model precision on the sensibility of the GRB detector. Journal of Space Craft Technology. 6, 1; 1996, July; 210-215.

The Gamma ray burst (GRB) payload on SROSS-C2 by virtue of its being in a $46^0$ inclination, 420x620km elliptic orbit, is often obliged to operate in environment where the incident particle and photon fluxes are best variable and intense. This variability due to the model precission and its associated long term radiation effects compromises the sensibility that can be achieved in orbit. An analysis of the effects of model precision on detecter sensibility awaits implications on the detection of GRB's are presented here.

------, -------, **STRUCTURE, SOFTWARE.**

196) SANT KUMAR. Soft ware for techno economic study for satellite offshore structue. Indian Journal of Petrolium and Geology. 2, 2; 1993, February; 89-98.

Several small oil bearing sturctuer are

generally discoverd when exploratory efforts for oil recovery are made. These small structure can only be developed when they are economically viable. Therefore need for the development of a tool was felt which can forcast the techno-economic viability for the development of these structures so that unnecesarily time is not wasted and expenditure is avoided. Deals with the models considering several variable, viz, deapth of oil accurance, number of well, type of well completion period of development, well productivety etc.

------, **SPACECRAFT, ACOUSTIC, DESIGN.**

197) REDDY (CVR) and PRABHU (MSS). Space craft and Acoustics. Journal of Space craft Technology. 3, 1; 1993, January; 325-35.

Discusses the importance of designing the environment of second system of the space craft for correct ground stimulation and execution of the test to qualify the space craft. For a successful flight of a space craft the acoustic environment is essential. Describes the fundamentals of acoustics, the acoustic sources and the important events that generate them and also the path charecteristics. The expertise and experience developed by ISRO during these years used for qualifying spacecraft of ISRO.

-----, ------, **SUBSISTEM, SOFT WARE, DEVELOPMENT.**

198) BALAJI(S). Software development for spacecraft onboard system using a high level langauge. Journal of Space craft Technology. 6, 1; 1996, January, 17-22.

In view of the flexibility offered by the

processor based system design, space craft subsystems now adays are designed with an embedded processor. Space craft onboard computer is responible for carrying out complex and critical functions such as attitude and orbit control, telecommunication and telemetry processing. This emphasis the need for the development of a methodology for the codesign of hardware and soft ware space craft. To meet the requirments of simplicity, case of development and efficient testing the use of high level langauges for software development is recommended. ADA is used for the first time in ISRO for developing onboard software. Some preliminary results are also presented.

--------, **SPACE VEHICLE, DESIGN.**

199) KASTURIRANGAN(K). Design of space vehicle. Bulletin of Meterial Science. 4, 3; 1982, March; 321-39.

To summarise the essential elements of space vehicle design . After giving on overview of the methodology of space craft sizing and configuration a brief outline of the technical consideration related to the design of different sub systems of the vehicle has been presented. The essential aspects related to manned system are also discussed . Concludes with the identification of some of the important payload interfaces that are relevent to the design of material processing experiments in space.

------- **TECHNOLOGY TRANSFER INTRIM.**

200) RAJ (GOPALAR N). ISRO: Spawns enterepreneur. Hindu Survey of India Industry. 5, 1995, 140-142.

ISRO is transferring its technology not just to public sector units, but also to private companies. The companies which have been estabilished with ISRO technology.They are Karnataka Hybrid micro devices, Indian resourses information managements technology.IRS satellite is used by Bellary steel. Large scale mapping for urban development has been done for several towns in Tamil Nadu. INTRIMT which specialies in using remote sensing and other modern tools for environment and resources management. Another one is ABR organics. ISRO helps the Hyderabad based company INTRIMT to provide this technology.

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|---|---|---|
| 1) Agropoedology | m | Hyderabad |
| 2) Bulletin, Astronomical society | q | Hyderabad |
| 3) Bulletin, Indian Vacuum society. | | |
| 4) Bulletin Indian Physics Association. | q | Bombay. |
| 5) Bulletin of Indian society for earth technology. | | |
| 6) Bulletin of ONGC. | .s.a | Dehradun. |
| 7) Bulletin of the Aeronotical society of India | q | Hyderabad. |
| 8) Chanakya Aerospace defence review | m | Allahabad |
| 9) Comsat technical review. | S.a | New York. |
| 10) Current science | fortnightly | Bangalore. |
| 11) Defece science journal. | q | New Delhi. |
| 12) Down to earth. | m | New Delhi. |
| 13) Electronics for you. | m | New Delhi |
| 14) Elecrtonics information and planning. | m | New Delhi. |

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|---|---|---|
| 15) Engineering Education. | q | Pune. |
| 16) Hindu survey of Indian Industry. | a | Madras |
| 17) Geological review | q | Culcutta |
| 18) IETE technicalreview | b.m. | New Delhi. |
| 19) Indian journal of cryogen | q | Culcutta. |
| 20) Indian journal of radio space physics. | b.m. | New Delhi. |
| 21) Indian remote sensing research bulletin. | q | Dehradun. |
| 22) Instruments and elecronics developments. | m | Bombay. |
| 23) Journal of the Aeronautical society. | q | Hyderabad. |
| 24) Journal of IETE. | b.m. | New Delhi. |
| 25) Journal of Maharashtra agricultural university. | q | Pune. |
| 26) Journal of oil seeds research. | s.a. | Hyderabad. |
| 27) Journal of petroleum and geology. | 3/y | Hyderabad. |
| 28) Journalnn of space craft technology. | s.m. | Bangalore. |
| 29) Mausam | q | New Delhi |
| 30) NRSA Technical report | Irregular | Calcutta |
| 31) Physics Education | q | New Delhi |

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| 32) Prceeding of the Indian Accademy of Sciences. | q | Banglore |
| 33) Science reporter | m | New Delhi |
| 34) Science today | m | New Delhi |
| 35) Telecommunications | b.m | New Delhi |
| 36) Telematics India | m | New Delhi |
| 37) Vayumandal | s.a | New Delhi |